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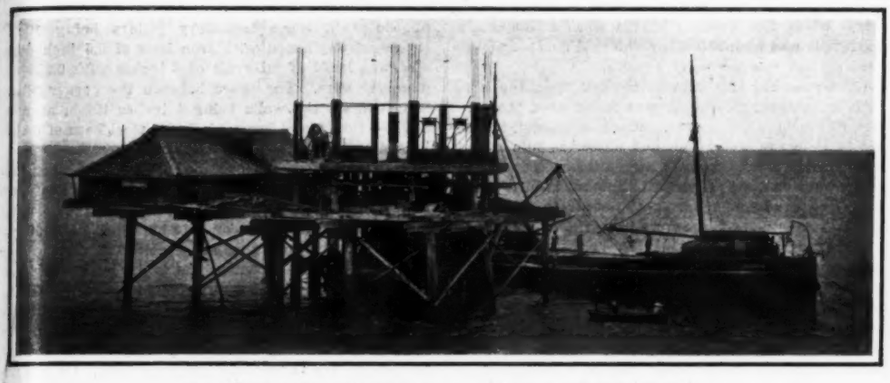
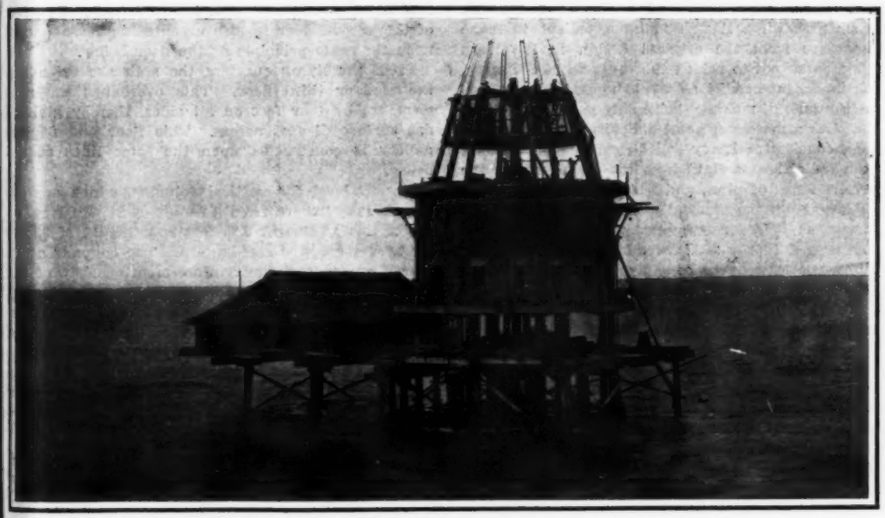
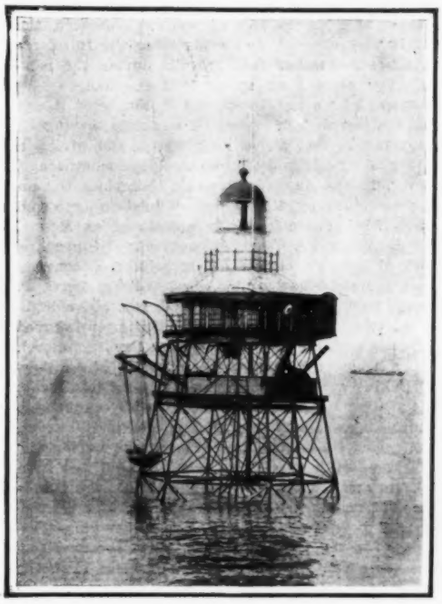


THE TEMPORARY STAGING AND HUT. SIXTH MONTH'S WORK.

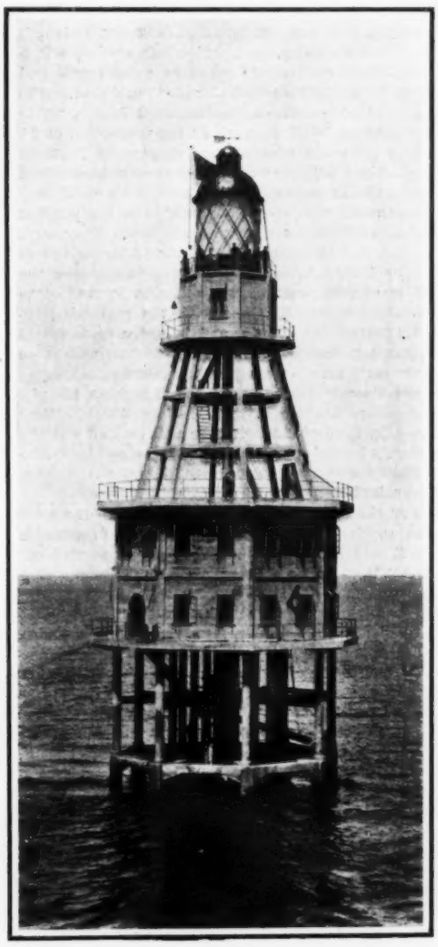


BUILDING THE RAKING COLUMNS TO CARRY LANTERN AND TOWER.

READY FOR THE LANTERN.



THE OLD LIGHTHOUSE.



THE LIGHTHOUSE COMPLETED.

REINFORCED CONCRETE LIGHTHOUSE, MALACCA STRAITS

REINFORCED CONCRETE LIGHTHOUSE.

THE NEW LANTERN IN THE STRAITS OF MALACCA.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

An interesting and novel application of concrete as a constructional material has recently been carried out in the erection of the new lighthouse at One Fathom Bank in the Straits of Malacca. This light is placed at a particularly dangerous point in the Straits in lat. N. 2 deg. 53 min., long. E. 10 deg., about 15 miles west of the coast line and about half a mile east of the shallowest part of the bank, which it indicates in some 18 feet of water. Moreover, the point is very exposed, and experiences the full force of the heavy weather that prevails during the monsoon. For some time up to 1874 the danger spot was marked by a lighthouse, but in that year it was supplanted by an iron screw-pile structure, having its focal plane 55 feet above high water, and giving a single white flash every minute. Some months ago, however, it was deemed advisable to replace the existing structure by a new one of modern type and capable of being seen from a greater distance. Messrs. Riley, Hargreaves & Co., Ltd., engineers of Singapore, submitted a design carried out in reinforced concrete upon the Hennebique system, designed by Mr. G. P. Thomas, having the focal plane 92.5 feet above high-water level. The suggestion of utilizing reinforced concrete in such a construction was at that time novel. The plans, however, received the approval of the Colonial Engineer and Surveyor-General of the Straits Settlements, and the work was forthwith commenced.

The subaqueous portion of the undertaking, however, proved of a difficult nature. The waves during the roughest weather often have a height of 8 feet from trough to crest, while the rise and fall of the tide is no less than 14 feet. The general design of the structure may be gathered from the accompanying illustrations, for which we are indebted to the constructional engineers. The base is octagonal in plan, the main building being carried on piles disposed in two annular rings—an inner and an outer—about a central pile 2 feet in diameter, and well braced together. The piles were carried out in reinforced concrete on the Hennebique system.

A staging was first erected on piles 50 feet in length by 18 inches diameter, upon which was erected a temporary hut at one end to serve as a workshop and to provide accommodations for the workmen. The concrete is composed of granite metal broken up to pass through a 0.75-inch mesh in the proportion of 2.5 parts to 1.5 parts of sand and 1 part of Portland cement. The reinforcing comprised steel rods of round section and 1.75 inches diameter laced with 0.1875-inch diameter steel wire every 6 inches. For the purpose of lightness the piles were made hollow. They were made 50.5 feet in length, eight being 18 inches square and nine 2 feet square. They were towed over the 15 miles of intervening water on rafts formed of 26 hogsheads strapped together with the pile lying between two rows of barrels, and in order to facilitate the release of the pile at the site the raft was made in four sections. Upon arrival at the lighthouse the raft was floated under the staging to beneath the pile driver, where a chain sling was attached to the head of the pile, the lashings with the raft cast off and the pile slowly heaved up, the raft being meanwhile gradually floated away, so as to leave the pile free when finally raised to a vertical position.

Heavy timber guides, clamped securely to the sides of the staging, served to keep the pile in position while it was being driven. Driving was carried out by two jets of water actuated by a steam pump playing at the foot of the pile. By this means it was found possible to sink the piles into the sand to an average depth of 15 feet in from three to four hours. In the course of sinking it was found that considerable erosion of the sand bank had occurred, a result no doubt due to the obstruction offered to the course of the tides, which here run very strongly, by the piles of the staging. Under these circumstances the resident engineer decided to carry out an experiment, by lengthening one of the piles by 14.5 feet, and ascertaining precisely to what depth it could be driven. The extension of the pile was carried out on the site, and it was found that hard bottom was gained after sinking the pile an additional 13 feet, or 26 feet 8.5 inches in all. Owing to the satisfactory results that had attended the lengthening of this pile on the site, combined with the fact that driving could be carried out another 13 feet and thereby gain a rock foundation, the other piles were similarly lengthened. The lengthening *modus operandi* adopted was to break the pile down to the hollow, which was then filled up with cement concrete of the same standard as the main fabric and a junction effected between the two parts by butting the bars of the extension in the corners of the existing pile, and covering the joint by a sleeve. Extra bars were then inserted in the sides of the pile and laced with steel wire as before. Molding boards were clamped to opposite sides of the pile, set plumb, and the remaining open sides then closed up with boards as the concrete was filled in and rammed down. When the molding boards were subsequently removed, it was found that the external surface of the added section was perfectly smooth.

In carrying out this extension work upon the pile, which is centrally placed, it was found that the concrete was somewhat porous. Since it proved impossible to keep the water out, and since the pile would have to carry a great proportion of the weight of the superstructure, it was decided to inclose it in a cylinder 5 feet in diameter sunk 10 feet into the sand. When this was done, the sand within the cylinder was excavated, and the whole annular space surrounding the pile within filled with cement concrete and continued up to the level of the main bracing. The average length of the submerged portion of the piles is some 52 feet below low water ordinary spring tides.

The inner ring of piles is spaced at a radius of 9 feet 9 inches, and the outer ring at a radius of 20 feet from the center. At a point 4 feet below high water the piles are connected by radial and wing beams. During erection, and owing to the rough weather prevailing, it was found expedient to make a departure from the original design in the main bracing, so as not to retard the progress of the work, which inclement conditions would moreover have rendered the task of making thoroughly good connections to the piles a matter of great difficulty. The amended bracing consists of heavy rolled-steel joists extending for the radial beams right from the center pile to the respective rings of piles, and which together with the wing beams are substantially clamped to the main fabric, so as to secure complete solidity. The joists were wrapped in the steel wire lacing, and but little difficulty was experienced in the subsequent molding.

At a height of 21 feet above this main bracing is the floor of the superstructure. This is carried on columns of 8 inches diameter, except in the case of the central column, which is of 2 feet diameter, forming extensions of the piles. In order to carry out the molding of the columns *in situ*, cast-iron molds in 30-inch lengths and having machined edges were prepared on shore. These were set up as required and were found completely satisfactory, the outer surface of the columns being very smooth upon the withdrawal of the molds. The armoring comprised steel bars of round section similarly bound at intervals of 6 inches with steel wire. An intermediate bracing is introduced midway between the main bracing and the floor of the building, comprising 12 x 14-inch radial beams strengthened by four 1.25-inch bars with 0.5-inch shearing bars between the tension bars.

The living quarters are in two floors. The structure is carried by radial beams and inner and outer ring beams. On the ground-floor level is a gallery completely surrounding the structure 5 feet in width, supported by a continuation of the radial beams in the form of a cantilever from the outer ring of columns, and to the outer edge of which gallery secondary radial beams extend from the inner ring beams.

The radial beams are molded to 10 x 12 inches at the center, increasing to 24 inches in thickness at the columns. The secondary radial beams are molded 10 x 8 inches, while the inner ring beams are 10.5 x 6 inches, and the outer ring beams 10 x 13 inches at the center by 24 inches at the columns, with an adequate system of tension and shearing bars. Around the outer edge of the gallery is a molded beam 10 inches deep by 8 inches wide, also strengthened with shearing and tension bars. The floor of the building is 5 inches in thickness, made of cement concrete and finished with cement mortar made up of 2 parts of sand to 1 of cement, strengthened by diameter bars spanning the floor between the main radial beams, and spaced 12 inches, and by cantilever bars over the beams spaced 8 inches, additional strength being secured by 0.3125-inch bars spanning the outer gallery beam and outer ring beams, spaced 6 inches. Cantilever bars were also put in over the beams at intervals of 6 inches.

The two floors of the living quarters are 24 feet in height, and the wall is carried up on the line of the outer ring of piles. The columns, which are a continuation of those below, are of the same dimensions, as is also that of the central pile. At the corners over the outer ring of these columns are five-sided pillars, which project slightly beyond the surface of the wall throughout the two floors, strengthened by four vertical iron bars of 1.25 inches diameter and likewise laced at intervals of 6 inches with steel wire. Midway between each of these corner pillars are auxiliary pillars flush with the external surface of the wall, these secondary pillars being 12 x 10 inches, strengthened with iron bars of 0.5 inch diameter, and laced at intervals of 6 inches with 0.125-inch diameter wire. The space between the corner pillars is walled in, the walls being 4 inches thick, armored both vertically and horizontally by steel bars of 0.3125-inch diameter 6 inches apart in each case.

The accommodation provided on the first floor comprises two storerooms occupying a space radiating 6 feet from the central pillar for oil, etc., two water tanks executed in ferro-concrete and each of 1,000 gallons capacity, the water being collected on the roof above and carried down to the tanks by suitable conduits; there are also a commodious kitchen and dining room, bath, and lavatory appointments. The building is entered by an arched entrance in one side of the wall, 8 feet in height by 6 feet wide, while light and ventilation are afforded by large windows. On the second floor are the sleeping quarters as well as other offices. Communication between the floors and the roof above is secured by a teak staircase. The floor of the second floor is also executed in ferro-concrete upon the same principle as the floor below.

From the living quarters the staircase extends to the roof or third floor. This overhangs the main structure by four feet on all sides, thereby giving a flat surface 44 feet across. This floor and flanking gallery is constructed upon the same lines as that below.

At this level the vertical columns, which are continued, rake inward from a radius of 24 feet from the center to a radius of 9.25 feet at a height of 30 feet to carry the tower and lantern. The columns are 12 inches square, and the reinforcement consists of four vertical rods of 1 inch diameter, strengthened as before by steel wire lacing at 6-inch intervals. The central vertical 2-foot column, which up to the level of this floor has been solid throughout, is continued up to the lantern room and made hollow throughout the remainder of its length, the clear internal diameter being 12 inches, so as to form a tube for the movement of the weight driving the optical apparatus. This hollow tube is reinforced by twelve 1-inch iron rods also braced every 6 inches with wire; and at a height of 4 feet 6 inches above the level of the third floor, a small opening in one side is provided, to facilitate the lighthouse crew gaining access to the weight within when desired. In the course of their height these raking columns are strengthened at two places by lateral bracing, which not only connect them to one another, but also to the central column. The lower bracings are the heaviest, being molded beams 9 inches wide by 10 inches deep, the upper bracing members being 8 inches wide by 9 inches thick. The armoring is the same in each case. Communication between the main building below and the lantern and service room is provided by means of three ladders, with a platform at the head of each of the main bracing, the well in the service room admitting to the steps being fitted with a gate. The service room is surrounded by a gallery 4 feet wide resting on the heads of the raking supporting columns to which the molded radial beams 9 x 6 inches are connected, the flooring being made up as before. The walls of this part of the structure are built in a similar manner to those below, with the corner pillars springing from the heads of the raking columns in the same manner, to a height of 11 feet 11.5 inches where is another gallery surrounding the lantern.

The new light is of the modern type and more powerful than the one which it replaces. The focal plane is raised an additional 37 feet 6 inches above high-water level, and instead of exhibiting a white light with a single flash every minute, gives a white light of a group of flashes every 15 seconds, which is visible at a distance of 15 miles at a height of 92 feet above the level of the water.

Access to the lighthouse is obtained by means of a stairway in two flights leading down from the lower gallery. They are built of teak, and the upper flight ends upon a roomy platform, also executed in ferro-concrete, the lower flight being hinged thereto, so as to permit of its adjustment according to the con-

tion of the tide. The platform is 4 feet above high-water mark, but as the ladder extends downward to low-water mark, it can easily and readily be set in position to suit any tidal condition, and thus afford direct landing from the boat.

As may be seen from the accompanying illustration of the completed building, the ferro-concrete insures a symmetrical and imposing structure to be secured, while it has the appearance of solidity characteristic of the usual masonry fabric. It is absolutely fireproof, since owing to the flexibility and possibilities of this system of construction, it is practicable to reduce the woodwork to the minimum even for internal fittings.

Moreover, it is perfectly hygienic. In comparison with a granite or stone building ferro-concrete is about fifty per cent cheaper, while the time occupied in construction is considerably less. This lighthouse was completed from the sinking of the piles up to the lantern level in twelve and one-half months, the setting of the lantern and its accessories, which weighed 17.5 tons, occupying a further six weeks. Moreover, the material is appreciably lighter than a stone building of a similar nature, the complete weight of the whole structure being less than 1,000 tons. The lighthouse has already been subjected to heavy stresses of water and wind, as during its erection the monsoons experienced were abnormally severe, and the ferro-concrete was observed to withstand the strains thus set up remarkably well.

DEVELOPMENT OF THE ELECTRIC RAILWAY.*

A RECORD OF MARVELOUS GROWTH.

BY JAMES N. HATCH.

Concluded from Supplement No. 1711, page 243.

DURING the six years from 1888, the time when the success of the street railway was assured, to 1894, when the street railway began to expand into the interurban railway, the growth of the electric street railway was very rapid. During these six years the electric railways of the United States increased from less than 300 miles in 1888 to over 10,000 miles in 1894.

It must be remarked, however, that this does not represent new enterprises altogether, for it was during this time that a great majority of the horse-car lines and steam dummy lines were changed over to electricity. It is shown that in 1888 there were 289 miles of electric railways and 6,800 miles of street railways propelled by other means; in 1892 the electric railways exceeded the combined mileage of all other kinds of street railways, there being 5,934 miles of electric against 5,695 miles of all other kinds, while in 1894 the electric railway had to its credit 13,598 miles of line, against 3,225 miles of all other kinds. This information should be considered in connection with the fact that cable railways continued to increase until 1894.

The most interesting problems in electric railway construction after 1894 were in the development of the interurban lines and the electrification of the elevated roads in New York and Chicago.

The elevated railway had proved its usefulness in several of the larger cities prior to 1894 but cars on these had all been propelled by steam power. These steam roads were successfully operated in the East for a number of years and seemed to give good satisfaction, and were profitable. But in Chicago the conditions proved different, either because their installation in Chicago came at a time when the people had become educated to something better, or because the people of Chicago would not be contented with a class of transportation which was considered adequate by the people of Boston and New York. At any rate the elevated roads which were started in Chicago with steam locomotives did not prosper, and it was not until electricity had been substituted for steam that these roads proved successful either from a financial or popular standpoint.

RAILWAY STATISTICS.

United States.			Foreign Countries.		
Years.	Steam Railways, Miles.	Electric Railways, Miles.	Country.	Steam Railways, Miles, 1908.	Electric Railways, Miles, 1900.
1880	93,262	.....	Germany.	30,777	3,006
1885	128,330	.....	Austria.	21,805	630
1886	136,338	8	Gt. Britain	21,529	2,400
1887	149,214	20	France.	25,898	1,200
1888	156,114	289	Russia.	26,414	.....
1889	161,276	805	Italy.	9,759	165
1890	166 654	1,262	Belgium.	3,781	35
1895	181,065	12,133	N'th'rl'nds	1,966	983
1900	194,262	19,314	Switz'rl'nd	2,302	109
1905	217,341	33,100	Spain.	8,103	349
1906	222,200	35,000	Sweden.	6,359	.. ...

The intramural railway at the Chicago World's Fair was the first electric elevated railway put into operation in the United States, and its very successful operation proved the practicability and reliability of electricity as a motive power for elevated railways, demonstrating the correctness of the contention made by Daft, Field, Sprague, and others who had carried on their experiments on the New York elevated roads, that electricity was superior to steam for that purpose. The third rail method of current distribution was also thoroughly demonstrated on the intramural road, and there was no further doubt of the thorough reliability of electric elevated railways for heavy traffic and frequent stops.

The Metropolitan Elevated Railway, in Chicago, was already projected at the time of the World's Fair and was designed for the use of steam locomotives. The Lake Street Elevated and the South Side Elevated were already in operation with steam locomotives. After the success of the intramural railway the Metropolitan Railway canceled the orders for steam locomotives and decided to adopt electric motors. The plan adopted was for a large electric motor car which acted in the place of the steam locomotive and hauled the train, all of which was composed of trailers. This was the first regular city electric elevated railway ever put into operation.

Largely as the result of the success of the intramural railway the Northwestern Elevated was projected in 1893, and the franchise was obtained with the express understanding that the road would be operated electrically. This was the first electric elevated railway ever designed, as such, in the United States. This was also the first four-track elevated road in Chicago, if not in the United States.

Not long after the World's Fair the South Side Elevated Railway decided to change its motive power from steam to electricity. At first thought this no doubt seemed a comparatively simple problem but a little investigation unearthed some very obstinate difficulties which seemed almost unsurmountable, if a single electric locomotive were to be used to haul a train of three or four cars. The need of long trains on this line was already obvious, but the structure was not heavy enough to safely carry such heavy motor cars as would be required to draw these trains. Mr. Frank Sprague, of New York, was invited by the engineers of the South Side Company to investigate the problem and submit a plan for the electrification. He very strongly recommended a system which he had invented a short time before, of multiple unit control, by which every car in the train could be a motor car if desirable and all could be operated by a master controller located at the head of the train. This system had not been put into practical operation prior to its use on the South Side road, and there was considerable speculation as to its practicability. But after the first few trials, which developed some rather serious miscalculations, the system worked splendidly. The system of multiple unit control has been very generally adopted in all electric train operation since its installation on the South Side elevated. A short time after the Chicago elevated roads had changed to electricity, the New York elevated followed.

Another interesting electrification problem which was carried out at the same time that the first elevated roads were changing to electricity, was the adoption of electric locomotives for hauling the steam trains through the Belt Line tunnel of the Baltimore & Ohio Railroad in Baltimore. The first of these locomotives was put in service in 1895. The use of steam locomotives in long tunnels had always been known to be a dangerous practice, owing to the deadly gases from the burning coal. There had already been a number of bad accidents in tunnels in which a number of lives were lost, and the need for a safe substitute for the steam locomotive had been very urgent for a long time. So the use of an electric locomotive for this purpose was felt to be very desirable, and this effort to use an electric locomotive in the Baltimore tunnel was watched with great interest. The success of this venture into an unknown field was assured almost from the start, and the electrification of other tunnels has followed. It goes without saying that all the newer tunnels now being constructed beneath the rivers in New York, Detroit and elsewhere for steam railways, will be operated electrically; and further than this, in many of the mountain tunnels of the West there is now under consideration the electrification of certain systems of road involving these tunnels. Another circumstance that makes this class of electrification desirable is that electric locomotives are much more efficient than steam locomotives on heavy grades, and heavy grades and mountain tunnels are generally found in close proximity.

The first interurban railway to be put in operation seems to have been out of Cleveland, although it is hard to distinguish between the urban and the interurban in many cases where the street car lines were extended further and further out of the cities along the country roads until they finally connected one city with other towns and cities and thus become interurban.

One of the earliest premeditated lines to be constructed was the Akron, Bedford & Cleveland. This road is 35 miles long and was first planned in 1892 and 1893, and was put in operation in 1894. At that time the direct-current transmission at a low voltage was the best known method of distributing current to the cars, and a line 35 miles long was a gigantic enterprise. In 1894 not only was high-tension transmission unheard of for electric railways, but the art of high-tension transmission for any purpose was only in its infancy. It will be remembered that it was not until the following year that the Niagara Falls transmission line was put into operation, and this has been considered the pioneer high-tension transmission line in this country, although there were some lines on the Pacific Coast constructed about this time.

The real growth of the long modern interurban railway began with the introduction of the rotary converter and high-tension alternating-current transmission into railway work. The first practical proposal for a line designed to use high-tension alternating-current and rotary converter sub-stations seems to have been in 1896, by B. J. Arnold, in plans for a road to run between Chicago and the Wisconsin Lake region. There was a rotary converter used prior to this in connection with a railway in Concord, New Hampshire, where the power was derived from a water-power plant, but this was at that time looked upon rather as a makeshift. Mr. Arnold's road to the lake region was never built, but the plans were utilized two years later upon another line which was operated very successfully from the start.

The central power station had been developed in the meantime with the introduction of large direct-connected units, replacing the small belted units previously employed. The efficacy of this method of power generation had been proved at the Chicago World's Fair in connection with the intramural railway. The large central power station seems now an indispensable adjunct to all modern interurban lines and is being substituted for the small isolated plant for every kind of electric railway. The intramural power plant was for direct current entirely, as in fact were all railway power plants prior to 1896, but the principles demonstrated applied equally well to either direct-current or alternating-current distribution.

As soon as the fact was fully demonstrated, that long electric lines were entirely feasible with A. C. distribution of power, the art of electric railroading had established itself on a permanent basis. And as fast service was established, the steam roads' standard of construction was adopted. On the best lines that have been constructed in the last five or six years, the grades and curves have been made very gradual and the rolling stock has been made capable of high speeds. The fact has now been demonstrated beyond dispute that as high speed can be attained by electric trains as by steam trains, and there seems to be no question but that the ease and safety will be favorable to the electric line.

The running of the long electric lines immediately parallel and adjacent to the competing steam lines has appeared to the layman an inexplicable riddle, but the reasons for this apparent phenomenon are sound business reasons.

The writer predicts that in the future the electric

* Paper read before the Western Society of Engineers.

roads will push more and more out into the undeveloped country, especially where water power is available, and as the freight and express business become more important factors.

The electrification of steam lines is becoming an accomplished fact, as illustrated by the New York Central Railroad in New York, and the other changes of less magnitude in the East. How rapidly this change from steam to electric propulsion of trains will be carried out on the trunk lines is hard to predict, but that the change will be made seems to the writer a foregone conclusion. The high speed electric railway is with us to stay. How great the change it will bring about in the civilization of this country is not possible to predict.

A NEW FORM OF DIRIGIBLE AIRSHIP.

THE MALECOT COMBINED AEROPLANE AND DIRIGIBLE BALLOON.

THE idea of the inventor of the combination aeroplane and dirigible illustrated herewith is to make use of two long aeroplanes placed beneath the gasbag for lifting a small proportion of the total weight, the greater part of the weight of the apparatus being raised by the gasbag itself. Another feature is the use of a suspended basket for tipping the balloon in a fore-and-aft direction. This basket therefore takes the place of the usual horizontal rudder.

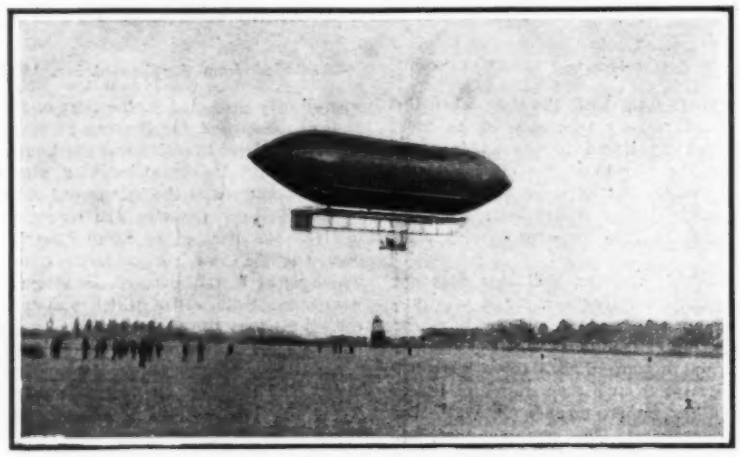
The envelope used in the Malecot dirigible is constructed of French silk. It consists of a central cylindrical portion with two ogival ends. The tensile strength of the silk used is 1,400 kilogrammes. The envelope is 33 meters (109 feet) long by 7.3 meters (24 feet) in diameter, and it contains 1,054 cubic meters of hydrogen gas, which gives it a total lifting capacity of about 2,500 pounds. The total excess weight of the machine over the amount lifted by the gasbag is 120 kilogrammes (250 pounds). This amount, therefore, has to be lifted by the aeroplanes when the dirigible is moving forward over the ground.

The framework which carries the aeroplanes and the car consists of a long bamboo pole 20 meters in length, which is fastened to other poles by means of braces of Alexandria metal. These are arranged in triangles with the apex downward, and are suitably braced with aluminium bronze wires. This arrangement is intended to prevent longitudinal distortion.

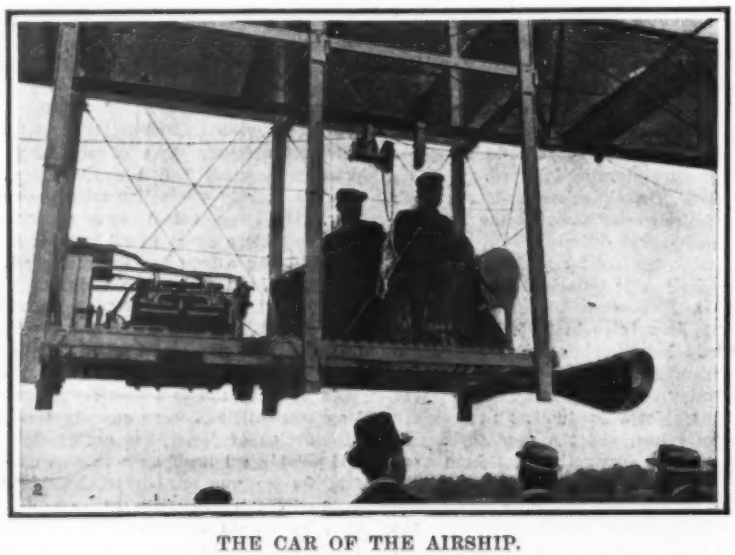
The car is supported from the center section of this framework by six vertical rods. It contains a 30-horse-power Buchet motor, which drives a 3.2-meter (10.5 foot) diameter propeller 400 R. P. M.

The two planes, arranged beneath the balloon on either side of its center line, are 20 meters (66 feet) long by 3 meters (10 feet) wide. There is a large vertical rudder at the rear. The basket below the car is attached to the two ends of a single rope that passes over pulleys at either end of the long bamboo framework that is wound around a windlass on the car. By turning the windlass, the aeronaut is able to move the basket forward or backward, and thus to incline the balloon downward or upward as desired. It is possible to carry a passenger in the basket, though this would be rather dangerous, and it is doubtful if anyone would be found to ride as ballast.

The combined airship has been tested successfully upon several occasions, and has made one or two quite lengthy flights. In the tests it showed considerable stability. The idea of using a shifting weight in place of a horizontal rudder has been tried in the past by Santos Dumont and also by Count Zeppelin, both of whom afterward abandoned it.



THE AIRSHIP IN FLIGHT AT ISSY-LES-MOULINEAUX.



THE CAR OF THE AIRSHIP.

A well-known American electrical engineer states that there are 20,000 miles of interurban electric railway in successful operation in the United States, and by the superior service afforded by the electric lines, as compared with steam railways, the former obtain 90 to 100 per cent of the local passenger traffic where competition occurs. Of 5,000 miles of electric railway track projected, 92 per cent runs parallel to existing steam railways; it is therefore urgently necessary for the steam lines to adopt electric traction lest they should lose their local traffic. Moreover, the introduction of the single-phase system has enabled the electric lines to compete still more keenly, and will stimulate their development.

PHOTOGRAPHIC EFFECTS OF METALS.

J. W. RUSSEL, who was the first to observe the photographic effects exerted by certain metals and oxidable organic substances, ascribed those phenomena to the action of hydrogen peroxide vapors, whereas other experimenters put them down to some special radiation ("metal" radiation) or ultra-violet rays. The photographic phenomena exhibited by substances treated with ozone have in their turn been ascribed to the action of hydrogen peroxide. As regards the nature of this action, opinions fluctuate between the hypothesis of an ordinary chemical reaction (Russel) and that of a peculiar radiation or radio-activity. In the Annalen der Physik S. Saeland endeavors to ascertain whether or not those photographic phenomena imply the existence of some special radiation given out by metals and other bodies, and what would be the nature of this radiation.

Mr. Saeland states that in atmospheric air (but not in the vacuum) a gradual diminution takes place in the activity of a metal ground with emery. If the metal be exposed to an intense illumination previous to the experiment, no effect whatsoever on the phenomenon is observed, nor is the metallic activity destroyed by an intense heating without lighting. As far as Saeland's experience goes, electric fields are not found to exert any action.

Experiments were also made at very low temperatures. No photographic action was noted after an exposure of five hours. On the other hand, the blackening of the photographic plate was reinforced considerably by allowing some time to elapse between exposure and development.

The phenomena show a marked difference from the effects produced on photographic plates by light rays, or any other known radiations, the decomposition of the silver bromide proceeding even after the apparent cause of the effects have been eliminated. Some active substance seems to accumulate on the plate, the photo-chemical reactions relatively slow at ordinary temperatures are accelerated, as are also all of the chemical reactions, by increasing the temperature.

Experiments made in exhausted air or in the vacuum show that the effects diminish in intensity, though they generally do not disappear completely. In fact, only in exceptional cases (when a very high vacuum was rapidly produced) was Saeland able completely to destroy the photographic effects of the metal investigated. This shows that the effects take place only in case the formation of H_2O_2 is possible, and are reduced considerably as this possibility decreases.

Amalgams, which according to previous experiments give rise to the formation of hydrogen peroxide, are remarkable for their very intense photographic effects.

Although according to Russel's experiments, the rectilinear propagation of photographic effects is extremely probable, Seeland made some special tests on metals separated from the plate by an intermediary tinfoil, which show that the propagation of the effects is somewhat similar to the diffusion of gases. It is interesting to note in this connection that identical results have been found by several experimenters in the case of photographic effects due to solutions of hydrogen peroxide.

One striking observation made by Saeland shows that photographic effects of metals, as well as those of hydrogen peroxide, are destroyed by certain metals, especially copper and brass. This observation would be accounted for by admitting that the vapors of H_2O_2, on their way from the immediate neighborhood of the metal or the solution toward the photographic plate, lose their photographic activity. Saeland describes a very pronounced activity through ordinary unperforated aluminium foil mounted between the plate and the metal under test in layers of ten sheets 0.0046 millimeter in total thickness. Although impervious to light, the sheets are readily traversed by the diffusion of hydrogen. These photographic effects however, are destroyed completely by the action of a suction air current of even moderate speed. From this he concluded that the photographic effects in question are merely chemical phenomena, identical in the case of metals and hydrogen peroxide solutions respectively. He therefore recommends more caution in cases of this kind, where the discovery of some photographic effect immediately gives rise to the hypothesis of some new radiation.

DEVELOPMENT OF THE MOTOR LIFE-BOAT.

A NEW TYPE OF CRAFT.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

SOME time ago we published in the SCIENTIFIC AMERICAN an illustrated description of the first motor-propelled life-boat that had been constructed for the National Royal Life Boat Institution of Great Britain, and which after issuing successfully through the official trials was stationed on the south coast. Since that time three other similar vessels have been converted to this mechanical propulsion, the equipment in each instance being different, the idea being to determine which class of motor and gear is best adapted to the rigorous requirements of life-boat service. Moreover, the vessels have not been especially built for the class of work, but are rather varying types of existing craft already in use, so that by experiment and experience it will be possible to evolve the most suitable type of hull for power life-boat work. In the fall of last year the fourth vessel of this class was completed and dispatched to the north-east coast of England, which is exceptionally exposed and where the effect of the gales is severely felt especially among the boats plying between England and the Baltic in the timber trade.

CAPSIZING THE MOTOR LIFE-BOAT.

To ascertain at what angle of keel the motor will stop.

BOAT COMMENCING TO RIGHT ITSELF.

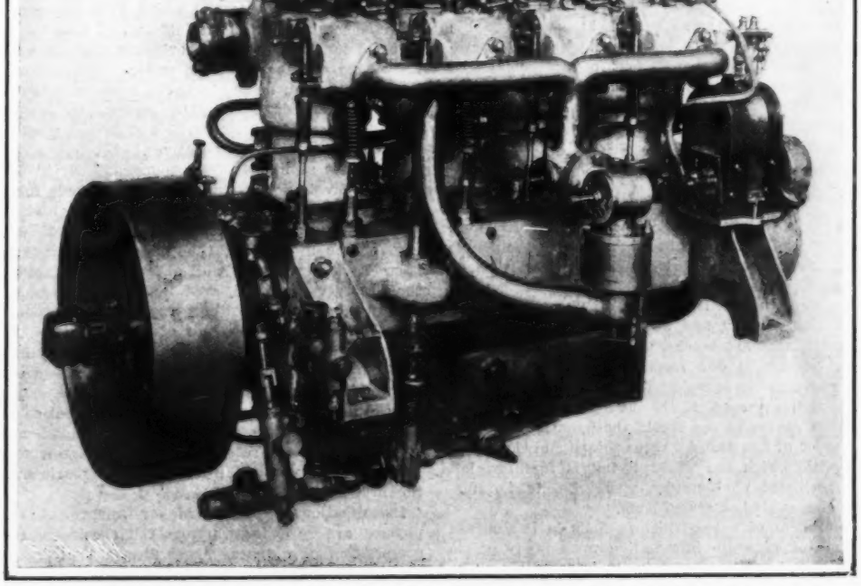
When righted motor is restarted to test efficiency of water tight casing.

This vessel is of the self-righting type, 42 feet in length, with a beam of 11 feet. It is rigged with two masts and two lug sails, while the draft with full crew of thirteen men and all stores aboard is 30 inches forward and 37 inches aft, and the dead weight is 10 tons. The motor is of the gasoline type having four vertical cylinders, separately cast, with a bore of 5 inches and a stroke of 5.25 inches. The crank shaft is hollow to allow of forced lubrication, and is made of chrome vanadium with a large bearing between each cylinder; low-tension magneto ignition is used. Two small plunger pumps are driven off the second shaft by means of an eccentric, one driving the bilge pump while the other maintains the air pressure in the gasoline reservoir to insure forced fuel feed to the vaporizer. The fly-wheel is very heavy, and the end of the crank-shaft at this point is fitted with a flexible coupling to which is bolted a short stub shaft connected to the reversing gear, this stub shaft passing through a gland in the watertight casing which completely incloses the motor to protect it in the event of the boat capsizing or becoming swamped.

The reversing gear is operated by means of two metal-to-metal clutches, one giving the forward, and the other the astern, motion to the propeller. The thrust of the propeller itself is used to force the male portion of these clutches home, and in this manner springs are entirely eliminated.

The lubrication of the engine and gear throughout is practically automatic, so that the boat may be run for several hours without it being necessary to open the hatches. The fuel tank has sufficient capacity for 40 gallons of gasoline and the consumption ranges from 2 to 2½ gallons of fuel per hour. Running at 850 revolutions per minute the engine develops 35 brake-horse-power, which on the measured mile official trials gave a speed of 7.2 miles per hour. The wheel control has three positions—"go ahead," "stop" (when the propeller shaft is disconnected from the driving mechanism), and "astern," the movements being facilitated by means of a pedal.

In the official capsizing trials in harbor the craft was subjected to a series of severe tests, the most important of which was the determination of the angle at which the motor was automatically cut out, and the time occupied in restarting the engines when the boat had righted itself after capsizing. For this purpose a special form of electric switch was used to cut out the engine ignition as soon as the angle of the keel reaches the prescribed point. The boat was placed beneath a crane, and a hawser passed completely round it. The craft was thus upset slowly until it floated keel upward, and when it passed just beyond the dead upside-down position it righted itself. The normal position of the boat regained, the builder's engineers stepped aboard and without opening the hatches restarted the engines, the operation being timed against a stop-watch. The motor was set going again in 32 seconds, thereby testifying to the efficiency of the watertight casing. It was subsequently dispatched to the station on the northeast coast and during the last winter gales, which were of great severity, it was subjected to very rough handling, which it survived so satisfactorily that two other boats of the same type have since been ordered.



A 35-HORSE-POWER GASOLINE ENGINE WITH WHICH THE MOTOR LIFE-BOAT IS EQUIPPED.

EFFECTS OF ELECTRIC LIGHT.

A. BROCA and F. Laporte give the results of many experiments on the physiological effects produced on the eye by the illuminations given by the various types of electric lamps used in practice. The acuity of the vision in the different cases was tested by the distance at which a given printed line ceases to be legible. Experiments were also made on the rapidity with which a given line could be made out. It is found that when the light from a mercury vapor lamp is balanced on the photometer head against the light from a carbon glow-lamp, then the illuminations produced by the two give the same practical visual acuity. The quickness of the reading is independent of the nature of the light. It is also independent of the values of the intensity of the light produced by each source—provided that these intensities are equal. The authors claim that their experiments prove that the ordinary commercial photometric tests of electric lamps are of real practical value. They recommend that an illumination of from 20 to 40 lux is most favorable for work. The effect of the contraction of the pupil of the eye by light-sources of great intensity was studied experimentally. The lower the visual acuity, as, for example, when the illumination is very feeble, the more harmful is the effect. When, however, an illumination of 20 or 40 lux is attained, it is of little importance. In certain cases, even when the illumination is very intense, a bright source in the immediate neighborhood increases the visible acuity, but in this case the eye gets rapidly very tired. A study is also made of the residual images latent in the eye after gazing at a bright source. The results accentuate the importance of having well-diffused light. The light from the mercury arc causes the pupil of the eye to contract even when the illumination is comparatively weak. This, therefore, is a drawback to its use, but there does not seem to be any physiological reason for avoiding this kind of illumination. If the eye cannot see the source directly, the quality of the light emitted by the various commercial lamps has little if any effect on the acuity of vision.

Paint for Petroleum Barrels.—Five parts of a weak glue or blood albumen solution are stirred with 20 parts of a 20 deg. Bé gravity water glass solution. Separate from this, stir together, according to the depth of color required, ultramarine, or smalt, or ground lapis lazuli, with as much kaolin or gypsum,

and 5 parts of water, so that a bluish milk liquid is produced, which is mixed with the water glass solution. In place of the glue or blood, fresh curds may be used and dissolved in the water-glass solution, into which the aqueous mineral color solution is introduced. Berlin blue or Paris blue cannot be used, because they would be decomposed by the alkaline constituents of the water glass. The paint should be applied thinly to the casks, which must be first rubbed off (scoured) with lime water, if possible in several coats, but never a second coat applied until the previous coat is dry.

PHOTOGRAPHY IN WORLD PROGRESS.

ITS VALUE TO SCIENCE.

BY W. I. SCANDLIN.*

How MANY people ever pause to consider the tremendous importance of photography in everyday life? Few, I believe, and even these often fail of its full appreciation from inability to establish a proper viewpoint.

Suppose it were possible for the reader to forget, for the moment, every impression that photography has made upon his mind, and to compare its emptiness with his present knowledge. He might then form some conception of its importance to himself, but would still miss much of its scope in fields with which he is unfamiliar.

Born, as it was, only sixty-eight years ago with Daguerre's discovery of a method for making sun pictures, photography has been developed, its methods improved, its scope extended, and its field of usefulness enlarged, until to-day it enters into every branch of scientific research, popular education, commercial activity, legal investigation, manufacturing achievement, military and naval warfare, pathological and surgical work, and into the exposition and consequent improvement of local conditions in every section of the civilized world.

Without photography or its equivalent, in its single application to the printing press for instance, the illustrations of the world to-day would be limited to the hand work of the artist, engraver, etcher, or lithographer of seventy years ago.

In its earliest stages, a single picture only was possible from each photographic exposure; but so rapid was its development, that only a few years passed before negatives were produced from which duplicate impressions could be printed. These negatives were at first crude, made on writing paper, sensitized, and rendered translucent by the application of hot wax. The great length of exposure made portraiture a difficult achievement; but as early as 1853 Victor Provost, a talented French artist and student of photography, produced a remarkable series of such waxed paper negatives, probably the first ever attempted for illustrative purposes. They include views in and about Castle Pierrefonds, France, made famous by the elder Dumas in his "Twenty Years After." Made within fourteen years of Daguerre's discovery, these negatives form one of the most important exhibits of early photography in its application to the illustration of historic literature.

With the simplification of processes, improvements in media and apparatus, the practice of photography has long since become universal; the work of the amateur is everywhere in evidence, and many of the most important advances in its applied fields are due to his efforts. Traveling every portion of the globe, he has not only exchanged pictorial records of modern civilization, but has also spread broadcast graphic illustrations of dynasties long dead. Thus photography has brought to the student of archeology the ruins of Egypt, the caves of the cliff dwellers, the relics of the Norsemen, and even the crude symbols of prehistoric man scratched in stone and ivory.

Every landscape photograph is a study in physical geography, picturing with a vividness and reality impossible in any other way, the vast ice fields of the frozen North, the tangled jungles of the tropic zones, and every physical feature lying between. It shows to the student in nature's own handwriting the course of mighty glaciers and of rivers long dried up; it tells the story of her cataclysms—of avalanche, earthquake, flood, volcano, and of tidal wave. It shows where the timber belt changes and at last stops short as the higher altitudes are reached; the mines and how the mineral wealth is dug from out the bowels of the earth and made to serve man's multitudinous requirements; rolling grain fields of the agricultural section; the cattle ranges of the West; the pampas of Brazil; the steppes of Russia. All these things and thousands more with which the world to-day is familiar, but which, without photography, would be, to the majority of mankind, a sealed book.

The student of natural history finds in it a means of obtaining accurate information upon many points impossible of solution prior to its introduction. The world-renowned achievements of Mr. Edweard Muybridge some thirty years ago in photographing birds and animals in motion have been followed everywhere by similar contributions, which have revolutionized many existing theories, and have thrown much new light upon the haunts and habits of the fauna of the world.

In the picturing of plant life, vegetable and fruit formation, the growth of fungi, insect life, the delicate tracery of the spider's architecture, the cloud forms, and all other of nature's wonders, photography has given the naturalist inestimable aid in his investigations.

Until the practical application of photography to the microscope, the student was compelled to draw or paint, at great expenditure of time and effort, all that he saw through the eyepiece. It is needless to say that work of this kind was very unsatisfactory; but photographic reproductions of wonderful accuracy are now possible, which may be still further enlarged in the projecting lantern. Thus the specialist demonstrates to his class in the lecture room or laboratory the progress of disease in the minutest structure of fiber, bone, or tissue; the colonization of bacteria in a drop of blood, the wonderful nerve centers of the human system; all these and many other things, photography makes clear under the hand of pathologists, bacteriologists, and the medical profession everywhere. With the introduction of the Lumière autochrome color plate during the past year, the various professions are now able to reproduce at one operation the above-named tissues in their true natural colors as they appear to the eye, an improvement of incalculable benefit to all students of medicine, natural history, and art.

In the collection of legal evidence, both with and without the microscope, it is in constant and ever-increasing use before the courts. Unmistakable evidence of forgery and erasure not discernible to the naked eye have been shown to jurors through the agency of photo-microscopy; sometimes by faint traces of an underlying portion of a signature not completely obliterated, and often by the condition of the surface fiber of the paper upon which the erasure had been made. By means of direct photographic enlargements, doubtful signatures have been compared with authentic ones with results that have carried convincing (and convicting) weight. An interesting case in point is that of a noted will bearing four signatures alleged to have been written by the same person, but which upon enlargement were shown to be so exactly similar in every particular as to prove that all four had been traced from the same original. In the identification of criminals, the establishment of disputed boundaries, in accidents, railroad wrecks, and fires, photography is indispensable. It is but just to add that the real value of much photographic evidence depends upon a knowledge of the conditions under which the negatives were made; and unless such knowledge is available, there is danger to the layman in accepting literally the apparent similarities of two or more photographs from different negatives.

Important as it is in these many and varied fields, photography is performing even more wonderful service to science in conjunction with the great telescopes of the astronomical observatories. As in the case of the microscope, the photographic dry plate records with exquisite detail and precision everything the observer sees, and even more than everything; for by reason of their long exposures, astronomical negatives show the presence of stars so small or so remote as to be invisible to the human eye, though aided by the most powerful telescopes. Almost every prominent observatory in the world has been engaged for the past twenty-five years in the preparation of a photographic chart of the heavens, which when finished will contain records of more than thirty millions of stars, varying in size from the fourteenth to the first magnitude.

Investigations into the higher science of astrophysics are revealing through the spectroscope the composition of the heavenly bodies, the presence or absence of different elements in their construction, and many other abstruse problems which photography alone can demonstrate.

The power of photography to picture the minutest details of an atom, itself invisible, or vividly to portray the grandest scenery of the universe, is no less wonderful than its new-found ability to show by means of the mysterious X-rays of the electric cathode the structure of the human body; its bones and cartilages; the organs and many of the processes of life, abnormal growths and diseased tissues, and to locate foreign substances within it. In the twelve or thirteen years since its discovery, X-ray photography has been of untold value in lessening suffering and death. It is being rapidly developed and perfected, and is now an indispensable adjunct to the equipment of the consulting room and hospital.

In the demonstration of scientific theories based on natural phenomena, photography is an impartial recorder of facts and conditions. A number of years ago, for instance, a noted French scientist advanced the theory that an object rapidly driven through the air would build up before it a cushion of compressed air and leave behind it a wake in just the same manner as does a boat propelled through the water. A bullet fired into a smoke-filled room was made to discharge an electric spark and release a shutter, photographing itself in flight. The resulting photographs clearly demonstrated his theory. The vibrations of a tuning fork in response to the notes of a musical instrument or the human voice have often been photographed to measure the varying length of sound waves.

Another of its recent important applications is to be found in the work of the topographer, by whom it is now almost universally employed. A topographical chart of the Yukon River district was recently plotted by the U. S. Coast and Geodetic Survey from a series of seventy-six photographic negatives. These negatives, made with lenses of known focal lengths and from certain carefully selected bases, furnished all the data from which, by elaborate mathematical calculations, every desired measurement of distance and altitude was obtained.

In the conduct of military and naval operations, the possibilities of photography have been long recognized, and a great deal of experimental work has been done to develop and perfect methods of photographing from balloons, captive and free, and from kites. Work of this nature is extremely difficult, but enough has been accomplished to demonstrate its value.

The use of photography in commercial life is familiar to all. The builder and contractor make daily photographic records of progress on the construction of skyscraper, subway, and battleship. The artist, architect, and sculptor keep in touch with all the examples of their craftsmanship by its means. The merchant shows his wares, and the manufacturer the products of his factory. An ingenious foreigner has lately invented a photographic method by which the weaving of every kind of fabric, from delicate silks and lace to rugs, carpets, and tapestries, may be greatly simplified and the cost materially reduced.

In its power to portray the human likeness, photography has been of inestimable value to mankind. Until its introduction portraits were beyond the reach of all but the wealthy; to-day there is little excuse for any family to be without pictures of its loved ones.

If in these achevements alone were to be found all that photography has accomplished, it might well be credited a tremendous force in world progress; but with them all and the sum of them there is still a single field in which it has done more than in all the others combined—its application to the printing press. Early in its development, photographic methods were employed in lithographic printing, and later in the production of relief plates chemically etched and adapted to the use of ordinary presses; but for years all these processes were restricted to the reproduction of black and white in lines or dots. In other words, every illustration had first to be redrawn and translated into lines, entirely destroying the photographic effect.

It was not until 1855 that a method of printing was found by which the photographic effect of tone and half-tone could be retained without redrawing. This method was costly, involving the use of specially

* Former editor The International Annual of Photography, etc.

constructed presses and gelatine plates. From it have developed other photo-gelatine processes and the intaglio process of photogravure. Beautiful as are the results of these processes, their cost and slowness of production render them impossible for general use.

About thirty years ago a method was found of mechanically breaking up the photograph into dots which could be chemically etched upon a printing plate. This was the beginning of the half-tone process of photo-engraving now so universally employed. No better illustration of its accuracy in reproducing the effect of the photographic original is needed than may be found within the pages of the SUPPLEMENT.

Only when one considers the vividness and enduring strength of an impression made upon the mind through pictorial demonstration, can one appreciate the value of photographs in popular education; and when it is remembered that thousands of printing presses in every quarter of the civilized world are pouring out, with photographic accuracy, steady streams of illustrations, covering every field of investigation, and at a cost so low as to make them everywhere available, its power as an impelling agent in world progress becomes apparent.

THE NORTHWEST PASSAGE.*

AMUNDSEN'S GREAT ACHIEVEMENT.

STRICTLY speaking, the northwest passage was accomplished in 1847, when Franklin and his men, retreating from their abandoned ships to the northwest of King William Land, passed through Simpson Strait to the mouth of the Great Fish River, and so crossed the tracks of Dease and Simpson, who in 1839 had reached Castor and Pollux Bay from the west. The existence of channels at least continuous, and possibly navigable, from east to west was thus proved. Later, in 1853, McClure and his men, abandoning the "Investigator" in Mercy Bay, Banks Land, which point she had reached from the Pacific, retreated to the ships of Belcher's squadron, then wintering on the southeast of Melville Island, and ultimately reached home. This was the first party to complete the traverse of the American Arctic regions from ocean to ocean. Technically, McClure did the northwest passage, but he proved at the same time that his route was quite impracticable. The "Enterprise," under Collinson, the "Investigator's" companion ship, did more toward the discovery of the passage by reaching Cambridge Bay from the west. Consequently, the only part untraversed by a ship was from the north of King William Land to the south of Victoria Land. A link of only some 200 miles (by the most direct channels) was all that remained to be forged when Amundsen planned and equipped his expedition in the "Gjöa." But these facts cannot detract from the interest of the two volumes before us; the length of the "Gjöa's" voyage, no less than its historical importance, justifies the many pages.

There is no doubt that Amundsen's expedition will live in the annals of polar exploration in virtue of the accomplishment of the northwest passage; but that was only its secondary aim. "Our first and foremost task was to obtain exact data as to the Magnetic Pole," says Amundsen, and repeats it several times. It had long been his ambition to navigate the northwest passage, but with a praiseworthy self-denial he compelled himself to keep the fulfillment of this feat of navigation subordinate to his scientific researches in magnetism. And yet in perusing the pages of the book one feels that the adventurous spirit of the Norseman was kept in check with difficulty; the desire to accomplish the passage was uppermost in his mind, and when once the greater part of the magnetic work was behind him his hearty enthusiasm seems to have been redoubled. However, in spite of this, Amundsen retained the "Gjöa" for nineteen months in winter quarters on the southeast of King William Land so that he could fulfill his programme of magnetic work, and this notwithstanding the fact that he saw open water ahead, and in all probability no obstacle in his road to the Pacific. That was an exhibition of devotion to scientific work in face of the greater fascination of an adventurous voyage which is most commendable and by no means common in polar exploration.

The "Gjöa"—a vessel of only forty-seven tons—left Christiania in 1903, and traversing Lancaster Sound and Barrow Strait reached Peel Sound. Amundsen was fortunate in finding Peel Sound open, as Franklin did in 1846 (but not so M'Clintock in 1858), and encountering no difficulties he sailed down Franklin Strait and entered Ross Strait to the east of King William Land. Here he was in virgin waters, for although M'Clintock had sledged down this strait in 1859, the "Erebus" and the "Terror" had passed to the west of King William Land in ignorance that there was a passage to the east. It was Rae who discovered the insularity of that land, and he held the opinion afterward shared by M'Clintock—that the only navigable passage was along its eastern and southern coasts. The ice passing southward through Victoria Strait, narrow and encumbered with islands as it is, was always prove as insuperable an obstacle as it had to the "Erebus" and the "Terror." Amundsen had reason to congratulate himself on following Rae's advice in this matter. Passing along Rae Strait the "Gjöa" went into winter quarters in September in a snug little harbor on the southeast of King William Land, since christened Gjöa Haven. The situation admirably suited the requirements of the work, which, the author explains, demanded such a distance from the magnetic pole that the inclination would be about 89 deg. From this base frequent excursions were made in all directions, Amundsen himself sledging on one occasion northward as far as the locality of the magnetic pole in Boothia Felix. By his observations he proved the truth of the theory that the magnetic pole has not a stationary position, but, on the contrary, is in continual movement within certain limits.

During April, May, and June, 1905, Lieut. Hansen, accompanied by Ristvedt, made a sledge journey to Victoria Land, and succeeded in charting, as far as 72 deg. N., the western shores of M'Clintock Channel, the supposed breadth of which he found had been much exaggerated. The new coast was named King Haakon VII. Coast. In addition, the "land seen by Rae" in Victoria Strait, which proved to be a group of many islands, was charted, though the work seems to have been done somewhat roughly. These surveys included all the topographical work of the expedition; nowhere else did the explorers touch quite new land. In August, 1905, the westward journey was resumed, and after some tortuous navigation through an island group in the north of Queen Maud Sea, Cambridge Bay was reached—the "farthest east" of Collinson's "Enterprise." Thence onward until King Point was made navigation was relatively simple, but at that point the "Gjöa" was stopped by ice, and compelled to pass a third winter. In the summer following she reached Nome City, and ultimately San Francisco, where she now lies, waiting, we understand, for the completion of the Panama Canal to return to Europe.

Amundsen thus accomplished the northwest passage, and, moreover, found a route that would probably be practicable for a small ship in any year if only Franklin Strait could once be reached from the east. The greatest difficulty in the whole passage lies in entering Franklin Strait, for Peel Sound and Bellot Strait, both of which Amundsen found open, may just as likely be blocked with pack-ice, as M'Clintock found them. Neither Ross nor Rae Straits appear to give much trouble, though in thick weather navigation in the vicinity of the magnetic pole must be, as the "Gjöa" found it, somewhat hazardous. The Esquimaux insist that Simpson Strait breaks up every year, and while Queen Maud Sea probably is seldom navigable, the passage through Palander or Markham Straits, though intricate, is possible; three fathoms was the shoalest water found.

Except for the work in Victoria Strait and M'Clintock Channel, the voyage can scarcely be called one of exploration. The greater part of the route was relatively well known and charted. The expedition was never absolutely out of touch with the civilized world. Even at King William Land they got a mail by Esquimaux from Cape Fullerton, Hudson Bay, while at King Point they were in the company of whalers, missionaries, and policemen. During that winter Amundsen made a journey to Eagle City to get into cable communication with Europe. The main scientific work, magnetism, was successfully carried out, and a good series of meteorological observations were taken, at least in winter quarters. Lindström, the cook, was an enthusiastic collector of plants and animals, but, though one of the party was a geologist, we do not gather that geological observations and collections were made, except a few fossils at Boothia Felix and King William Land. That is a pity in view of the many opportunities that must have occurred during a voyage practically always within touch of land. Nor do we gather that any soundings were taken other than those essential for the navigation of the "Gjöa"; certainly none are indicated on the outline maps which accompany the volume. However, with regard to the Esquimaux encountered, very full information is given. The first two winters were passed in the company of the little-known Nechilli tribe. They appear to be one of the few tribes of Esquimaux who fortunately have had little or no contact with white men, though it was from members of this tribe that Rae got the news of Franklin's fate.

Amundsen tells his story in a lucid, interesting style, and, though the book would not lose by condensation in places, it is singularly free from the trivialities with which such volumes are often loaded. But an appendix of scientific results would have given more permanent value to these volumes.

One rather serious error on page 59 should be mentioned. The author speaks of passing through Bellot Strait when he evidently only passed by the end of it. A very full and accurate index is provided.—Nature.

*"The North-West Passage." Being a Record of a Voyage of Exploration of the Ship "Gjöa," 1903-7. By Roald Amundsen; with a Supplement by Lieut. Hansen. 2 vols. Pp. xiii+335 and pp. ix+397; illustrated. London: A. Constable and Co., Ltd., 1908.)

ACTION OF RADIUM EMANATION ON COPPER SALTS.

By Mme. CURIE and Mlle. GLEDITSCH.

MESSRS. RAMSAY and Cameron announced a year ago that they observed the production of alkaline metals and lithium in solutions of copper salts which were submitted to the action of radium emanation, and they concluded that they had an example of transformation of the elements. The copper was changed to elements of the same group having a less atomic weight, such as potassium, sodium, and lithium. In their experiments a copper solution placed in a bulb was left in contact with a strong radium emanation. The copper was separated, and the residue examined. It consisted especially of a sodium salt, with a small amount of potassium and calcium. Lithium was detected by the spectroscope. In a check solution, the residue was much less, and lithium was not found. Madame Curie and Mlle. Gleditsch recently repeated the experiment. It is very difficult to have chemical products which are quite free from lithium, and this latter is found in distilled water and in nearly all the reagents. If a substance is left in a glass vessel for a time, it is found to contain traces of lithium. It was therefore necessary to replace the glass by another material. Quartz is objectionable, as the commercial quartz vessels also contain lithium. Platinum was finally used in the form of a cylinder 3 inches long and 0.6 inch diameter, placed horizontally, and having at the end a small platinum tube for introducing the solution. The reagents were purified so as to be free from lithium. The pure copper salts of commerce, as Mr. Ramsay remarked, are found to contain lithium. The copper salts were purified by a special process, so that finally they were quite free from the metal. The radium emanation was furnished by a solution containing 0.19 gramme of radium (or 0.25 gramme of radium chloride). It was introduced into the apparatus after having been first condensed in a worm-tube placed in liquid air. After the copper salt (sulphate of copper) had been acted upon for some time by the emanation, the solution was withdrawn and placed in a platinum crucible. The copper was deposited electrolytically by means of a platinum electrode plate, and the residue of copper was precipitated by hydrogen sulphide. The liquid was then evaporated and the very slight residue weighed. A like amount (7 cubic centimeters) of pure copper sulphate solution which had not received the emanation was likewise treated and the two residues were examined by the spectroscope. The weights of the residue of the solution heated with radium were 0.0004 and 0.0005 gramme, and for the untreated solution, 0.0003 and 0.0002 gramme. The amount of copper used was about the same as in Mr. Ramsay's work, but the residue was much smaller. Spectroscopic tests showed that the residue contained mainly sodium and a small amount of potassium, but lithium was not found. The residue is in any case much smaller than that obtained by Mr. Ramsay, and this is probably due to the suppression of the glass. A number of check experiments were made, and the result is that the present experimenters were not able to confirm the results obtained by Messrs. Ramsay and Cameron. Although they cannot affirm that no trace of sodium or lithium is formed in the experiments, they consider that the fact of the formation of these elements cannot be said to be established.

The State Department makes the announcement officially that the world's fair which was to have been held at Tokio in 1912 has been postponed by the Japanese until the year 1917.

CURIOUS PUMPKINS.

SOME STRANGE MEMBERS OF THE CUCUMBER FAMILY.

Many different kinds of pumpkins are cultivated, and these, together with melons, gourds, and butter-apples, are the most curious representatives of the cucumber family. Some of these vegetables reach extraordinary dimensions. For example, there was exhibited several years ago an enormous specimen which was grown in the plains of Colorado. It measured not less than 5 feet in length and weighed 386 pounds. Other members of the same family grow into strange and picturesque shapes, well illustrated by the photographs which we reproduce. Some resemble turbans or serpents, some are like the domes of mosques, and some even like the head-dresses at a carnival.

SERPENT-LIKE GHERKINS.

WOMEN COLLECTING SEEDS.

In France the seeds of the pumpkin are sown in April in a hotbed under glass; then they are thinned out and finally transplanted to a bed in the open air during the month of May. This operation necessitates several preliminaries. A few days before the final transplanting it is necessary to dig holes from 4 feet to 6 feet away from each other, according to the kind of seed planted. These holes are then filled with manure, to which a little potash has been added, and the whole is covered up with good earth. When this is done a gourd seedling is planted in the middle of each hole, and care taken to cover it up with earth as far as the first leaves. The plant must be watered frequently in order to facilitate growth, and if the heat of the sun is too strong it may be covered with a little straw. In cold frosty weather it is usual in France to place a hand-glass over each seedling. In hot weather the plants are watered more frequently. When the gourd stems are about 3 feet in length they are layered; that is to say, pegged down so that they may take root. This method of procedure hastens the growth. As soon as a fruit forms, the extremity of the branch bearing it is cut off just above the next knot, and naturally it is taken off altogether if it seems misshapen. The market gardeners on the outskirts of Paris have learned how to raise splendid gourds, and never allow more than one fruit to grow on one stalk. They cultivate all the edible varieties and even grow bitter apples, which are rather ornamental than otherwise when grown in gardens.

The different kinds of pumpkins grow in the shape of a more or less flattened sphere. The best known varieties are Mammoth Pumpkins, which are of such an enormous size and such a well-rounded appearance as to distinguish them from all others, and the gourds called the Gardener's Favorite or the large yellow Dutch are cultivated exclusively in the surroundings of Paris. The flesh of this kind, from 1 inch to 3 inches thick, is found slightly sweet and of a beautiful orange yellow. Other kinds are the tea-gourds of Etampes, and the gray gourds of Boulogne that are frequently seen in the kitchen gardens in the middle of France and which differ from the other kinds mentioned in the greenish gray tinge of the skin. The Turban pumpkins are remarkable on account of their shape. People say that the Turks have let fall the covering of their heads on the field which we show. Among pumpkins with leaves bearing stiff and prickly hairs ovoid or elliptical fruits are found of variable size and with or without longitudinal sides. One of the best known is the pumpkin of Touraine, with a smooth skin of a pretty green color; there is a large pumpkin whose diameter lengthways often exceeds 19 inches, which is chiefly noteworthy for the extraordinary number of excrescences covering the surface. Square melons, also called Spanish artichokes, although they probably came originally from Mexico, are not the least curious specimens of the members of the cucumber family. Their color varies from yellow to green. Certain kinds are striped with white and green; the flesh is pale in color, rather stringy but very good all the same. They are seen on fruiterers' stalls or in restaurant windows. When the skin is soft, they are packed up in baskets ready to be sent away. Italian gourds are long in shape and of a yellowish green color. On seeing them one would be more inclined to think they were clubs belonging to wrestlers at a fair rather than fruit. Portuguese gourds, too, with their reddish sides, do they not seem like the top of certain oriental mosques that a hurricane has hurled on the ground? These last two kinds of gourds demand more heat than the others; they are cultivated chiefly in the south of Europe and in the Antilles. Their surface is covered with a kind of powdery down, and the flesh, firm and not stringy, varying in color from pale yellow to blood red, possesses a more or less perfumed taste. Even French gourds are seldom eaten in their natural condition. They are made into soup, with water or with milk, and thus prepared they form a very healthy food. Peasants in the south make tarts and sweetmeats of them for their children; they also fry them as they would potatoes. In olden times they used to take the seeds out of a gourd and then dry it and serve it with different sauces. Roman slaves were thus fed. This practice has been kept up for a long while in Italy, and is still carried out in the neighborhood of Genoa. In conclusion, let it be noted that Parisian gardeners, in order to preserve the purity of strain of their gourds, collect the seeds themselves each year. In proof of this, one of our pictures shows the women breaking open the very hard skins of the gourds with a hammer to take out the seeds, while other workers cut the fruits up into four parts and tear away the interior pulp. In Anjou an edible oil is extracted from the pulp, but this grows rancid rather quickly. In short, pumpkins are extremely curious plants as well as very useful ones.—Country Life (London).

TURBAN PUMPKINS.

REMOVING STRAW MATS FROM TOURAINE PUMPKINS

To Bleach Leather, Ivory, Bone, and Horn.—Digest the leather for an hour at 40 deg. C. (104 deg. F.) in benzine, to remove fat and tannin; pour the fluid off and remove the benzine, by heating in a water-bath, and then treat with liquid sulphurous acid or Javelle water or peroxide of hydrogen, with ammonia, etc. In every case, we obtain an excellent article, that becomes a bright pink white and which, after careful drying, is admirably adapted for album bindings and fine handwork. In bleaching ivory, horn, and bone make up an essential peroxide of hydrogen, by shaking up peroxide of hydrogen water with ether or benzine. They must be separated by means of a separating funnel and the ivory, horn, or bone treated with this peroxide of hydrogen solution containing about 50 volumes of oxygen. By this means, we dissolve the fat and bleach by a single operation. This method of bleaching is very costly and only to be recommended for fine work.

RARE AQUATIC BIRDS.

SOME CURIOSITIES IN THE BERLIN ZOOLOGICAL GARDENS.

BY PROF. L. HECK.

ALTHOUGH in these columns birds are less frequently the subject of illustrative treatment than mammals, our readers will doubtless find liberal compensation for the apparent omission, in the accompanying excellent picture, drawn from life by Paul Neumann. It shows, grouped in captivating fashion, a selection of choice varieties and gems from the class of aquatic birds as well as stilt-legged bipeds, which wade on more or less long legs in shallow waters, in the marshy, often flooded lowlands, together with water fowl proper, which, on account of the swimming web between the toes, are most at home in the liquid element.

Less exclusively confined to still or flowing water but rather inhabitants of moor, brush- and swamplands, are the cranes, which not only differ from the other well-known stilt-leg birds, the herons and the storks in appearance, but are also plainly distinct from them in their habits of life and diet, being particularly feeders on vegetable substances. In the zoological gardens, the three types of stilt birds are constantly confounded, but on looking at a crane, the visitor need only glance at its food receptacle, containing grain and wheaten bread, to recognize at once that he is not looking at a fish-heron or a frog-hunting stork. The two types of cranes represented in our illustration belong to the most beautiful and the rarest of their kind, and are among the most valuable birds that a zoological garden can own. Both fully make good their claim to the characteristics of the species; the Japanese-Chinese white-necked crane (No. 7) by the sharply marked white part of the neck, contrasting with its beautiful plumage, in splendid shades of gray, and the South African tasseled crane (No. 9) distinguished by a pair of remarkable feathered flaps on the neck, beneath the bill, and the base of the beak above covered with red pimples.

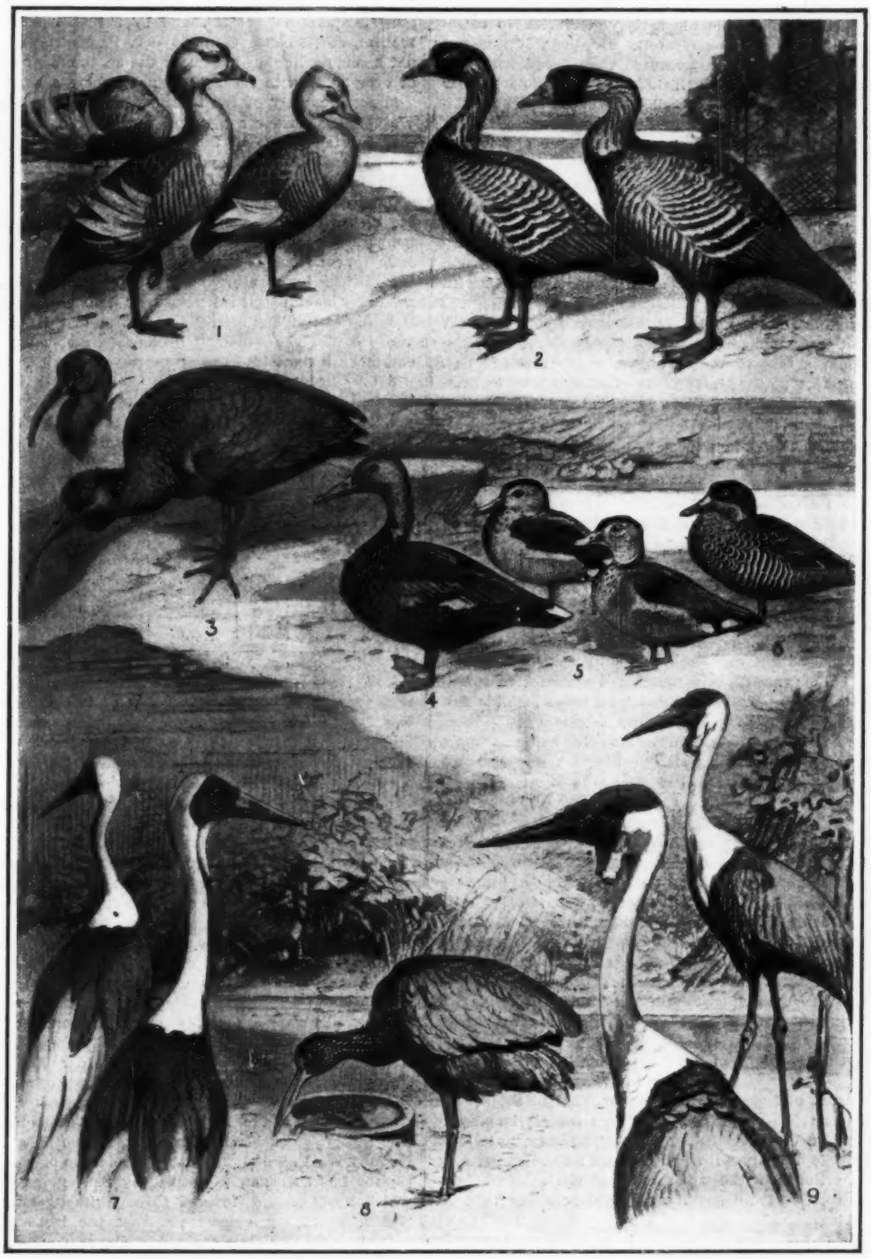
In the modern system of classifying birds, the cranes come nearest to the pictured representatives of the rails, of which the largest in the family, as the name indicates, is the so-called giant rail (No. 8). Among the rails, the transformation stage between land and water species can be very closely traced, for the so-called water hens, which also belong to this class, swim and dive as well as any aquatic bird, although they have no distinctive webbed or swimming feet. The giant rail, which is a native of Brazil, and attains the size of an ibis, represents the land type of this class, living in the high red grass of the scrub and fallow land, partaking of both animal and vegetable food. It is very rare in zoological gardens. The one shown in the illustration is the first living specimen exhibited here.

The ibises come nearest to the storks, but differ from them externally in their soft, sickle-shaped, curved bill and small size, but in both respects show resemblance to the latter through the so-called wood pelican or wood ibis. The best-known type is the sacred ibis of the ancient Egyptians, which, however, with its naked, black-skinned head and neck, presents an altogether different appearance from the Chilian spectacled ibis (No. 3), also shown herewith, which has, surrounding its eyes, a naked belt, resembling spectacles and just as bare and as black as its chin laps. The plumage is gray in front and above, shot with rusty red, behind and beneath it is black.

The Sandwich goose (No. 2), that takes its title from the group of islands of the same name in the Pacific Ocean, brings us to the swimming birds. It is an almost extinct animal, which at one time, breeding happily and innocently on the ground on the peaceful shores of the islands, undisturbed by beasts of prey or civilized man, is now threatened with complete extermination by imported dogs and cats. It is a relative of the northern barnacle or nun goose which, according to an old popular fable, grew on trees, and like that bird it has a delicate head and pretty beak. The color is pale brownish gray, with black head and neck rings, and front neck of a yellowish brown. It is very rarely that the Sandwich goose is found on sale in the modern animal market.

Next as regards size comes the Indian red-head duck (No. 4), the euphonious name of which will arouse in the reader poetical imaginings of its beauty. As a matter of fact, it has a short downy plumage of a very beautiful roseate tint on its head and neck, but otherwise it is of a wholly monotonous dusky brown color, its whole figure, with its great, broad, flat beak, being so far removed from gracefulness and so unprepossessing that its *tout ensemble* does not convey the impression of a beautiful animal. A great rarity among the swimming birds obtainable by zoos it undoubtedly is; it was in consequence offered only by English dealers, if at all, at a price calculated to make such a bird a terror, but recently, for a good round sum, I succeeded in obtaining a specimen.

The Eytons tree ducks (No. 1), from Australia, and their entire kind, the pretty, attractive tree duck, black caps on their heads and the fine wavings and dotted markings on the body; also the red-shoulder teal (No. 5), which, in addition to the sharply defined black line on head and neck, is distinguished by the reddish brown shoulder markings, as the name indicates. The hooded duck has been more frequently found in the market during the past few years. The



RARE AQUATIC BIRDS IN THE BERLIN ZOOLOGICAL GARDENS.

1. Eylon's Tree Duck. 2. Sandwich Geese. 3. Spectacled Ibis. 4. Red Head Duck. 5. Red Shoulder Teal. 6. Hooded Duck. 7. White Necked Crane. 8. Giant Rail. 9. Tasseled Crane. Drawn from life by Paul Neumann.

exhibit, in their long legs, something gooselike. The name "tree duck," according to Reichenow, is really merited only by some species that actually perch a great deal on trees and build their nests in them. Our variety is particularly striking in appearance and attracts the attention even of the unsophisticated, owing to its long, lancet-shaped Isabella colored (yellowish brown) switch feathers, worn on the closed wings, which impart to the bird an altogether peculiar appearance.

Finally, a few remarks on the two Brazilian-Argentine little ducks in our pictorial group which we include in the teal-duck species. They are exceedingly beautiful creatures, pretty dwarf varieties among the ducks, as are also our northern teal and "Knäk" ducks, as well as the hooded ducks (No. 6), with the red-shoulder teal, on the other hand, is a rare little cabinet specimen, and is seldom found in the aquatic bird collections of our gardens.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Illustrirte Zeitung.

A consular report dealing with the trade of Shasi for the year 1907 says that Chinese and Japanese engineers have been engaged in surveying the route for the proposed Hankow-Ch'engtu Railway, and have actually marked out the line in the neighborhood of Ichang. There is talk of work being commenced at Ichang at an early date, but it is reported on good authority that the funds in hand are only sufficient for about 120 li (40 miles), and that a section of 60 li (20 miles) at the Hankow end will be constructed first.

THE ABSOLUTE ZERO OF TEMPERATURE.*

WHAT IT MEANS TO THE PHYSICIST.

BY FRANCIS HYNDMAN.

Nearly two centuries have elapsed since Fahrenheit invented the temperature scale which goes by his name, and which is still used in this country, in fit company with our antiquated weights and measures. Fahrenheit divided the interval between melting ice and boiling water into 180 degrees, and found that his thermometer stood at 32 degrees below the first point when subjected to the greatest cold known to him. He called this his zero, and started to calculate his temperatures from it. However, it was not long before lower temperatures were found both naturally and produced artificially, so that the scale has no meaning, and might well be replaced by the sensible and convenient Centigrade scale.

In the investigation of gases, such as air, it was very soon discovered that, when heated or cooled in an inclosed space, the change in the pressure which they exert upon the walls is proportional to the change of temperature. If the pressure has a value of, say, 1 pound per square foot, it will become very nearly 274/273 pound if the temperature rises, and 272/273 pound if the temperature falls 1 deg. C. with all gases. However, with vapors (see below) the change is not so simple. If this were exactly true for some particular gas—it is very nearly so for helium—it follows that by reducing the temperature 273 deg. below zero C., the temperature of melting ice, the pressure would become $0/273 = 0$ pound per square inch, and that this must be the limit. This was very clearly shown by the late Lord Kelvin in 1848, and called the absolute zero of temperature, while temperatures reckoned from it are called absolute temperatures, or temperatures Kelvin. Thus, the boiling point of water is 100 deg. C., or $100 + 273 = 373$ deg. K., and we have the simple relation that the pressure of a gas is proportional to its temperature Kelvin. It is really remarkable that the latest and most careful measurements show that this early value was very nearly exact, and it now appears that the most probable value for 0 deg. C. on the Kelvin scale is —273.10 deg. C., and that this is the proportion of the pressure change for helium, and is very nearly the same for hydrogen and air. We shall find later why these small differences arise, and their meaning.

It has been said that at the zero Kelvin there would be no pressure, and we may consider briefly the physical meaning of this. To do so, it is necessary to depart from the realm of fact, and to employ a theory which has so well answered all calls upon it that its main teachings may be taken with some degree of confidence. The kinetic theory of gases assumes that all gases consist of a vast assemblage of very small solid particles or molecules. In simple gases these are all exactly alike, and there are about three hundred thousand million in every cubic thousandth of an inch of the atmosphere, all trying to move in straight lines with the enormous velocity of about two and a half miles a minute. Even minute masses moving at such speeds can give quite considerable blows, and as the walls of the containing vessel are struck many million times a second, the combined effect is evenly distributed, and is what we know as the pressure of the gas. It is proportional to the square of the velocity, and we have seen that it is proportional to the absolute temperature. Hence, it follows that the velocity with which these molecules move is proportional to the square root of the absolute temperature, and we get the physical meaning of temperature.

At the absolute zero there is thus no pressure and no motion, the molecules being quite inert. However, with all known substances before this point is reached the gas changes its condition, becoming successively vapor, liquid, and solid (with the exception of helium, which has not yet been solidified). There are two causes which tend to produce these results—the one that the molecules have some size, although very small, so that the actual space in which they are free to move is not quite as large as the containing vessel. The second cause is that, like all matter known to us, the molecules exert a kind of gravitational attraction on one another, and that there is thus a very slight tendency among them to collect together. Thus the great differences in properties which substances exhibit are due to the very different value of this attraction and the size and speed of the molecules in them.

At the ordinary temperature, gold is a solid, mercury a liquid, carbonic acid gas a vapor, and hydrogen a gas because of the relation between these quantities in each, and when we know them they enable us to predict with some certainty the behavior of the substance under very different conditions. To follow this a little further, we may consider what would happen to carbonic acid gas and to hydrogen if we were to compress each of them strongly at the ordinary temperature. It is found by actual experiment that at, say, 15 deg. C. = 59 deg. F., hydrogen will not become a liquid even under the enormous pressure of over 30 tons to the square inch, whereas carbonic acid requires only 1-3 ton to cause it to become liquid. We call the former a gas and the latter a vapor, so that substances are in the state of vapor when they can be condensed to a liquid by pressure *alone*.

As has been pointed out above, all known substances can be liquefied if cooled sufficiently, and we see that in cooling a substance, such as hydrogen, a temperature must be reached at which it is first possible to condense it to a liquid. This is known as the critical temperature, and the pressure which is necessary as the critical pressure. The clear understanding of this has been the beginning of the modern knowledge of the liquefaction of gases, and has given enormous insight into the properties of matter.

Before considering any special cases more in detail, it will be interesting to trace the progress in the subject as recorded by the date of, and the means employed to achieve various important steps.

Date.	Temperature.		Name of Experimenter.	Place.	Substance.
	Centigrade	Kelvin			
	Deg.	Deg.			
171a	— 17.0	256.0	Fahrenheit.	.....	Salammoniac and snow.
1778	— 40.0	233.0	Van Marum.	Leiden.	Liquid ammonia
1823	—102.0	171.0	Faraday.	London.	Liquid chlorine.
1877	—103.0	170.0	Cailletet.	Chatillon	Liquid ethylene.
1877	—183.0	90.0	Pictet.	Geneva.	Liquid oxygen.
1898	—252.0	14.0	Dewar.	London.	Solid hydrogen.
1908	—269.0	4.0	Onnes.	Leiden.	Liquid helium.

Two main ideas have been continuously followed side by side throughout the course of this work—the one the desire to liquefy some gas and to study the properties of the liquid; the other the desire to arrive at continuously lower temperatures for the purpose of studying the properties of other substances under these new conditions. The first is exemplified by the researches of Van Marum and others, but more particularly of Faraday, all of whom employed the method of producing the substances under such conditions in an inclosed space that the pressure became high enough to condense the vapor; but the liquid was not free, and hence could not possibly be used for further research. In this manner these experimenters—and especially Faraday—liquefied all the then known gases and vapors, with the exception of those which he called the permanent gases (hydrogen, oxygen, nitrogen, and a few others), from the conviction that these were different in their nature. It was, however, shown, in 1873, by Van der Waals, of Amsterdam, using the data obtained by Andrews of Belfast with carbon dioxide, that there was a continuity between the gaseous and liquid conditions. The theory which he put forward has been most wonderfully fruitful, and the extreme boldness of his conception has been amply justified by the new relations which have been discovered through its agency. It was a gratifying coincidence that the last of the known gases which remained unliquefied was conquered just at the time that Van der Waals was retiring from his professorship, thus giving the last and most brilliant confirmation to his views as expounded thirty-five years ago. His great conception is known as the law of corresponding states, and seeks to reduce the behavior of all gases and liquids to a system, so that the study of any one, under certain given conditions, would admit of the prediction of the properties of some other substance under conditions which would be practically unattainable. Suppose we consider the properties of oxygen at about the ordinary temperature (say 35 deg. C.), and under a pressure equal to 116 atmospheres, and we know its critical temperature to be 154 deg. K., and its critical pressure to be 58 atmospheres. Now, if we divide 35 deg. C. + 273 = 308 deg. K. by 154 we get 2, and 116 by 58 we get also 2, values which are known as the *reduced* temperature and pressure, and the theory says that substances should behave similarly at the same reduced temperature and pressure. It should, however, be explained at once that there is not a complete agreement; but the very small differences which are found in a large number of cases only serve to prove the fruitfulness of the conception and to show the line for future investigation. To take an extreme case as an example. Water is both a liquid and a solid at ordinary temperatures, and has a critical temperature at 420 deg. C., and a critical pressure of about 300 atmospheres. Hence, its reduced temperature of 2 will occur at 1,110 deg. C., and its reduced pressure of 2 at 600 atmospheres—that is to say, measurements with it in the condition of a gas would be quite outside the experimental limits at the present time.

In the same way the investigation of the behavior of vapors not far removed from their boiling-points, combined with the principle of corresponding states, enabled the general principles to be laid down by which all recent investigation has been carried on.

For instance, as early as 1884, Wroblewski was able to infer from his measurements on hydrogen that this gas, which was by many even then thought to be unliquefiable, would behave like all others at what was, however, thought to be an unattainably low temperature. With the exception of helium, which was not known to exist on the earth until 1895, hydrogen at the ordinary temperature is further removed from its critical point than any other known substance, and hence is in a condition which was at that time unique.

To obtain liquids of very low temperature in open vessels was an enormous step from the small quantities seen in tubes by the earlier experimenters, and this advance is due to Pictet and Cailletet, who obtained other liquids in this condition besides those mentioned in the above table. To do this they employed the method of cooling one gas under pressure by passing it through a tube immersed in some other liquefied gas, which was kept boiling at a suitable pressure by means of pumps. This method has been applied with great success to liquefy every gas but helium and hydrogen. To obtain these in the liquid condition, it was necessary to make use of a remarkable property which all gases exhibit. This, the well-known Joule-Kelvin effect, is the change of temperature which a gas exhibits when it is caused to expand through a fine jet. Now, all gases but hydrogen and helium are cooled when they are expanded, and if this cooling is allowed to add itself up, the result is that any of these gases, if expanded through a fine jet, will be cooled to the liquefying temperature without the use of any other cooling influence. This principle has been followed with great success by Linde and then Hampson in their air liquefiers, which produce liquid air as an article of commerce. When, however, hydrogen, and still more, helium, are expanded under these conditions, they are found to be *heated*, and not cooled. It is found that they must be cooled first before they are expanded—hydrogen to about —80 deg. C., and helium to as low a temperature as about 40 deg. K., before it is possible for them to cool themselves by expansion. Both these gases have now been brought to the liquid state by this means and by the use of the silvered vacuum glasses which were invented by Dewar. In these the transference of heat is so extraordinarily small that one containing liquid air with a temperature of —193 deg. C. can be held in the hand without any difficulty. Even liquid hydrogen, with a temperature of —253 deg. C., can be kept in a glass which is immersed in liquid air, and it will no doubt not be long before it will be possible to pour liquid helium, which boils at 4.5 deg. K., from one vessel to another. When it is considered that the step from Fahrenheit's zero to boiling oxygen is not so great or so difficult as from this to boiling hydrogen (20 K.), and that the further step to boiling helium, 4.5 K., is still greater and more difficult, some idea will be obtained of the immense perseverance and consummate experimental skill which has been required to make this last step possible, and to bring man's knowledge to such a stage. It is probable that the lowest temperature yet obtained is about 3 deg. K. in liquid helium, which was caused to boil at a small pressure. However, still smaller pressures are possible, or, perhaps, the helium will solidify so that a somewhat lower temperature will be certainly obtained in the near future. No one yet knows how the next step can be obtained; but it may lie in the hands of the discoverer on this earth of some still rarer gas, such as the coronium of the sun's furthest atmosphere.

* English Mechanic and World of Science.

THE BALANCING OF FOODS.*

A SIMPLE EXPLANATION OF THE SCIENCE OF BEING FED.

THE chemical substances of which the body is composed are very similar to those of the foods that nourish it, since they are made up of the same chemical elements. There are from fifteen to twenty of these, the most abundant being oxygen, hydrogen, carbon, nitrogen, calcium, phosphorus, and sulphur.

These elements are so combined as to form a great variety of compounds in both body and food, the most important being protein, fats, carbohydrates, mineral matters, and water. The functions of these compounds in food are to build and repair the various tissues of the body and to supply it with heat and muscular energy. The refuse and water in them are non-nutrient, but form a very large per cent in many of them.

Water contributes over 60 per cent to the weight of the average man and is an important constituent, therefore, of our food, though it cannot be burned and hence does not yield energy.

The protein compounds (albuminoids, gelatinoids, and extractives) include the principal nitrogenous compounds and form about 18 per cent of the weight of the body, being the building materials that make up and repair the framework, and also rendering service as fuel.

A good caterer will furnish protein, therefore, in the shape of meat, fish, eggs, and dairy products, also in dried legumes—as beans and peas—and the cereals. The protein in meats varies greatly; it is much more abundant in beef, veal, and mutton than in pork and fish, and in cereals it is more abundant in oats and the least abundant in rye and buckwheat.

The albuminoids (white of egg, lean of meat, curd of milk, and gluten of wheat, etc.), and gelatinoids, classed together as proteids, are most important constituents of our food, as they are the basis of bone, muscle, and other tissues and also yield energy.

The extractives, which are the principal ingredients of meat extracts, beef tea, and so forth, contain nitrogen, and although they neither build tissues nor furnish energy are valuable because they act as stimulants and appetizers. The craving for meat is perhaps due in part to a desire for these extractives.

The fats furnish about 15 per cent of the weight of an average man, though overfed people with little exercise are liable to grow fatter. But the tendency to fatness or leanness is more or less a question of personal idiosyncrasy, or some other little understood factor, and is not decided by food and exercise alone.

About nine-tenths of this element, which furnishes most of the fuel for the habitation of the soul, is also obtained from the animal foods—including cream, butter, and eggs—as well as nuts, oils, oatmeal, and maize, but the fuel value varies within wide limits, being greatest in those materials which contain the most fat and the least water.

The carbohydrates form only a very small proportion of the body tissues—less than 1 per cent of weight—but they are important because they are an abundant source of energy and easily digested. They play their part as fuel also, as they include the starch of bread and potatoes, and sugars, which are changed to fat in the body and stored as such.

So the enlightened caterer will add to her menu cereal, sweet bread, crisp, well washed vegetables and fruits, sugar, molasses, honey, and so forth. But the energy latent in the food must be developed by its consumption in the body, and the process is something like the burning of coal in the heaters of your houses, and must be furnished to supply oxygen; so the good housewife will see to it that the atmosphere of her living room is refreshed from God's free air.

Mineral matters, though yielding little energy and forming only 5 or 6 per cent of the weight, are yet indispensable to the body, for they are the mineral parts of the bones and teeth, and are present also in other tissues, and in solution are in the fluids as well. They include phosphate of lime, potassium, sodium, magnesium, and iron, and are necessary to life. But the housewife cannot go far astray in the provision of this element, as it is present in all the ordinary articles of food.

Now we have been considering food as a source of heat and muscular power, but there is no doubt that intellectual activity also is dependent upon its consumption; just what substances and what quantity of them is required to produce brain and nerve force the physiological chemist has not yet declared.

The cooking of food has much to do with its nutritive value, though, and given the same material, two cooks may achieve entirely different results; for while a thoughtless one would probably burn the meat and serve soggy potatoes, that require twice the time that mealy ones do to digest in her haste to "get it over," the intelligent, conscientious housekeeper would see that pots and pans are clean, and that the heat is properly regulated, the process timed correctly and the meal served in an attractive way.

Daintiness in serving a meal has a hygienic as well as an æsthetic value, for things which please the senses stimulate the flow of digestive juices and aid assimilation; and "we live not upon what we eat, but upon what we digest."

The careful caterer must learn to group her menus in a way that each meal will supply all the elements of which we have been talking in the proper proportion; otherwise a one-sided diet may result that fails of the necessary balance. If a person consumes a large amount of beef or mutton and little vegetable food the diet will be too rich in protein and poor in carbohydrates.

On the other hand if pastry, bread and butter, and tea are consumed in preference to a more varied diet the food will furnish too much energy with too little building material. For instance, the hog and hominy diet supplies liberal quantities of energy, but is very deficient in protein, as illustrated in the diet of negroes in the black belt, with 62 grammes of protein and 3,270 calories of energy per man per day, very little over half the protein needed, for it has been estimated that an average man at moderately active labor should have 115 grammes, or a quarter of a pound, of available protein and enough fats and carbohydrates in addition to yield 3,400 calories of energy per day, though a man in sedentary employment needs less of both.

The early summer dinner of auld lang syne of lamb and peas with a salad, bread and butter, and a little fruit perhaps, makes a good example of a well-balanced meal, and there is a good reason for the potatoes or parsnips or sweet potatoes with roast beef.

But there is another thing of which the truly hygienic housewife will take cognizance. Digestibility is often confused with another very different thing, namely, the agreeing or disagreeing of the food with the particular individual.

Different persons are differently constituted with respect to the chemical changes which their food undergoes and the effect produced thereby, so that it is literally true that "one man's meat may be another man's poison," and every man must learn from his own experience what food "agrees" with him and what does not. All persons are alike in that they must have protein for the building and repair of the bodily machine and fuel ingredients for warmth and work, but differ in the amounts and proportions required.

Scrupulous neatness should always be observed in keeping and serving food, for the sake of health as well as decency. There is death in the refrigerator sometimes when it looks quite innocent, for of all places on earth cleanliness should permeate there.

It is not enough to scrub and scald it, even with concentrated lye, for the air passages and the minute crevices of the walls are not reached and the box is often not nearly as sweet as it looks in the care of the reputed careful housekeeper. But the home where the sulphur candle is lighted will have a purer atmosphere than one where it is omitted; and the refrigerator especially should be treated to this vapor bath about once a week, though in handling the burning candle great care must be observed against inhaling its fumes.

Pecuniary economy of food is always entirely compatible with good living when the cook knows her business. The plain, substantial, standard food materials, like the cheapest cuts of meat and the ordinary vegetables, are as digestible and nutritious as any of the costlier materials; but the trouble is that we endeavor to make our diet suit our palate by paying high prices for the raw material rather than by the skillful cooking and tasteful service that are in the reach of all, rich or poor.

The trimmings of meat which are left with the butcher or thrown away in the kitchen contain one-eighth of the material paid for, that might be saved in a savory pot of soup, and the neck bone of beef—after all the meat has been removed—which is thrown away makes the best soup stock in the world.

It is such cuts of meat as loin of beef, rib chops of lamb and similar parts in which most of the waste occurs; in fact one-fifth of the cost goes to pay for the bone. Such cuts therefore should be avoided by those who wish to get the most actual nutriment for their money.

Another loss, though a lesser one, occurs in the preparation of fruits and vegetables for cooking, in which process the careless cook can easily cut so deeply in paring them that quite a large part of the edible portion is lost. Another source of waste is in the cooking itself, and boiling is the most abused branch of all. Rapid boiling should always be avoided, for no additional heat is generated by the furious ebullitions, and much of the aroma and nutriment of the immersed substance is thus lost.

* The Housekeeper.

REGENERATING RUBBER BY A NEW PROCESS.

A NEW process for regenerating rubber scrap is described by M. Lixier. The process is based on the discovery that terpineol, in the solid or liquid state, coming from essential oils or else of synthetic fabrication, and also the oxygenated derivatives of the terperic carbides which are analogous to terpineol, possess a dissolving power which is quite remarkable for vulcanized or ordinary rubber. These bodies dissolve the rubber slowly when in the cold, but more rapidly when heated. The rubber can be recuperated from the solution in a great degree of purity and elasticity, being non-vulcanized, and can thus be vulcanized afresh when desired. In employing terpineol as a solvent, which is the essential part of the process, it is possible to prepare concentrated solutions of rubber at a low temperature. In this way the characteristic physical qualities are not attacked, and the impurities such as mineral matter, tissues, etc., which are insoluble in the terpineol, can be removed by filtering or decanting. Other impurities soluble in terpineol can be removed by adding liquids which are miscible with the former and these will precipitate the impurities without precipitating the rubber. On the other hand, we may add other miscible liquids in order to accomplish the reverse effect and precipitate the rubber, leaving the other matter in solution. These two methods for taking out the soluble impurities can be combined by using the two kinds of precipitating agents and removing the thrown-down matter in succession. The type of the first agents of precipitation is benzine and the type of the second kind is alcohol or acetone. As to the choice of the agent and the exact method to be followed, it naturally depends upon the nature and quantity of the impurities. In practice we proceed in the following manner. The rubber scrap is reduced to a pulp and is placed to digest at a temperature of 100 to 150 deg. C. in a closed apparatus which is provided with an agitator, together with a sufficient amount of terpineol, for instance, 2 parts of terpineol for 1 part of rubber. When the solution is completely carried out, we add four times the volume of benzine, for instance, agitate thoroughly, then filter or else allow to settle and decant the liquid. The clear liquid is distilled in order to take off the benzine, and then we add, while constantly agitating, a certain amount of alcohol or acetone to the gummy solution of terpineol until all the rubber is precipitated in a homogeneous gummy mass. The liquid is decanted and the mass is washed with the precipitating agent until it is freed from the terpineol. Afterward the rubber is washed with water and dried. The terpineol and also the alcohol or other agent can be recovered by the distillation so as to be used repeatedly in the process. One advantage which is given by the present method is that it allows of incorporating other gummy substances with the rubber in order to improve the quality or to give it a special character, such as copal or similar substances which are soluble in terpineol. To this end we make two separate solutions in terpineol and add them so as to mix the two substances before precipitating them.

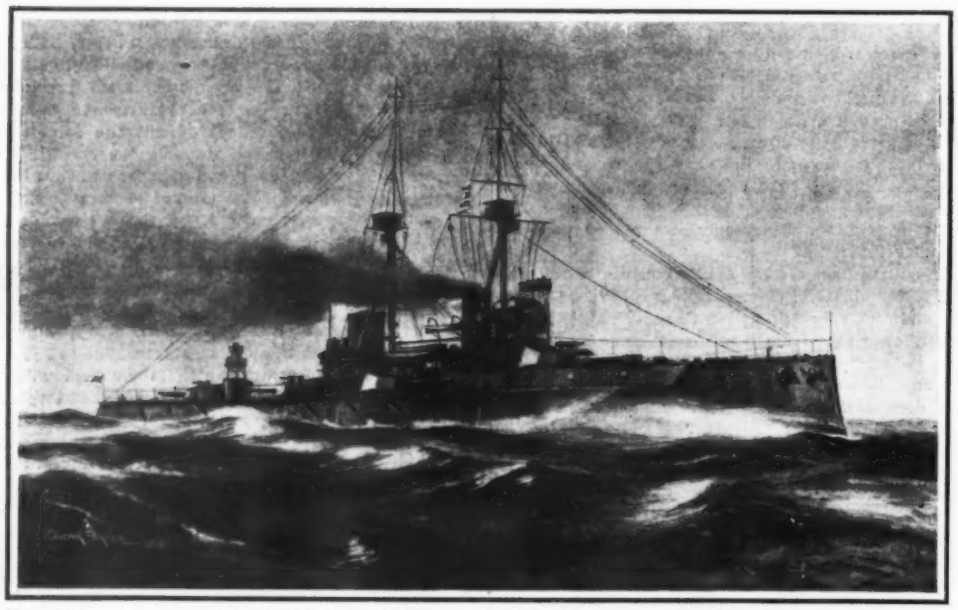
Bleaching Shellac.—Dissolve 500 parts of shellac in 2,000 parts of absolute alcohol and place the solution, for a few days, in a warm place. Then make a paste from 500 parts of chloride of lime of at least 20 per cent and 1,500 parts of water, by careful trituration, place it on a linen cloth, and after all the liquid has run off, wash the residue with 500 parts of water. To the collected fluid, we now add so much of a solution, consisting of 1 part of potash and 3 parts of water, until no more precipitate is produced. To 500 parts of chloride of lime, use, on an average, 125 parts of potash. The fluid must be filtered clear of the sediment, add the filtrate, stirring constantly, to the still warm shellac solution, and after half an hour, add hydrochloric acid, until the whole shows a decided acid reaction. The shellac separates as a tough, perfectly white mass, which is removed from the acid fluid, and washed out in boiling water until the latter when running off no longer presents a milky appearance; then the shellac is formed into tape-like strips, which are dried in the sun and air. The acid lye is saturated with hydrate of lime (burned and slaked lime) and the alcohol distilled out.

THE BRITISH BATTLESHIP "ST. VINCENT."

THE EIGHTH OF THE "DREADNOUGHT" CLASS.

To THE untrained eye the "St. Vincent," practically the eighth of the "Dreadnought" type to be built for the British navy, will look to be exactly identical with the original "Dreadnought"; and, indeed, in the essential features, visible in the engraving, she is identical, the vessel being of about the same length; having the same number of turrets similarly disposed; the same number of smokestacks and masts, and the same forecastle deck and lofty freeboard. Although, in the several trial cruises of the "Dreadnought," certain minor defects were developed, the general plan of the vessel was found to be so satisfactory that the later ships of this type have followed her lines very closely. The "St. Vincent" is 500 feet in length, with 84 feet beam, and 27 feet draft; her displacement is 19,250 tons, and she is driven by Parsons turbines which, it is expected, will develop a speed of 21 knots.

The armament of ten 12-inch guns is mounted as follows: Two in a turret on the forecastle deck, with a command of about 32 feet above the sea; two on each beam, amidships, on the main deck (the forecastle deck being cut away to allow these guns to fire ahead parallel with the axis of the ship); two on the center line, immediately aft of the after funnel, and another pair on the quarter deck. This disposition of the guns allows of concentration of six 12-inch ahead; ten on each broadside; and six astern.



The Graphic. THE LATEST BRITISH BATTLESHIP "ST. VINCENT."

Displacement, 19,250 tons. **Speed,** 21 knots. **Coal,** 2,700 tons. **Armament:** Ten 12-inch, 50-caliber guns; eighteen 4-inch guns. **Armor:** Belt, 11-inch; gun positions, 8 inch to 11 inch.

In the "Dreadnought" the secondary armament for the repelling of torpedo boats consisted of 12-pounders. In the "St. Vincent" the 12-pounders have been replaced by 4-inch guns, ten of which are mounted in pairs on the roofs of the 12-inch gun turrets, and the others on the superstructure.

The greatest improvement in the "St. Vincent" over the "Dreadnought" is in the distribution of the armor and in the provisions made in the interior of the ship for protection against injury by gun or torpedo. The waterline is protected by a continuous belt of 11-inch Krupp steel, associated with protective steel decks and 11-inch bulkheads. The gun positions are protected by from 8 to 11 inches of armor, the barbettes upon which the turrets rest and turn being carried down through the protective decks to the level of the main armor decks. Also a particular study has been made of the internal subdivision of the ship, which includes special bulkheads, and an unusually large number of separate watertight compartments.

The "St. Vincent" will carry two tripod military masts, each mounting a fire-control platform, although it has been rumored that the question of abolishing the tripod mast and returning to the simple vertical mast is being agitated in the Admiralty. A notable feature in the ship is the small, compact, but very lofty navigating platform, carried above the bridge, which, it will be noted, is itself of limited dimensions.

The widest bridge in the world is 790 feet wide, accommodates 33 tracks crossing H street, at the Union Terminal Station, in Washington, D. C., and was opened to traffic in 1907. The longest three-hinged arch span has a length of 540 feet between centers of end hinges, crosses the Connecticut River above Bellows Falls at Rockingham, Vt., and North Walpole, N. H., and was completed in 1905.

THE HUDSON'S BAY COMPANY.

THE history of the famous Hudson's Bay Company dates from 1670, when a license to trade in furs in Hudson (now Hudson's) Bay was granted to a company which included several men of high rank. The Duke of York, the Duke of Albemarle, and the Earl of Shaftesbury were among them.

The capital was £8,420, not a great amount with which to fight the rival companies and the intrepid individual agents, chiefly French, whose competition was hard on the new enterprise. But the conquest of Canada helped it a great deal. English traders learned the ways of the Indians and their system of the exchange of goods.

Toward 1684 some merchants of Montreal combined to explore the fur country and founded that powerful Northwest Company which soon became the center of the fur trade. In 1798 this new company shipped furs to the value of no less than £120,000, and the existence of the Hudson's Bay Company was again threatened.

In "Conjurer's House" Stewart Edward White has given us glimpses of the picturesquely high-handed methods of "the company"—which nowadays has but one meaning, the Hudson's Bay Company. But according to a writer in Fur News its early rival was no better.

"It shrank from no act, however iniquitous," says the account. "Its agents imposed on their own employes and speculated on the misery of the Indians, consequently realizing immense profits in spite of the competition of new Russian and American companies."

The American Fur Company, for instance, was founded in 1809 with a capital of $1,000,000 and operated west of the Rocky Mountains. The competition of all these rivals put the Hudson's Bay Company into greater danger than it ever had been.

But in 1821 a treaty was made amalgamating the Hudson Bay and Northwest companies under the title the Hudson's Bay Fur Company. At present it has only one rival of importance, the American St. Louis Fur Company.

The Hudson's Bay Company has posts scattered over a domain covering 3,700,000 square miles. Its principal establishments are on James Bay and toward the frontiers of upper Canada, on lakes Athabasca, Winnipeg, Methye, and near the Columbia, Mackenzie, Saskatchewan, and Assiniboine rivers. Fort York, commanding the course of the River Nelson, is the headquarters of the company and contains its principal depot.

In 1842 it took a lease of all the Russian establishments in North America at an annual rent of £40,000, so that it is now working on its own account the vast tracts of country between the Mississippi and the Pacific Ocean.

The following is a list of the quantities of skins and furs dispatched to Europe by the Hudson's Bay Company in 1833-34, which will give an exact idea of the extent of its trade:

Beavers	1,074
Skins and young beavers	92,094
Muskrats	694,092
Badgers	1,069
Bears	7,451
Ermines	491
Foxes	9,937
Lynxes	14,255
Sables	64,490
Polecats	25,100
Otters	22,303
Raccoons	713
Swans	7,918
Wolves	8,484
Wolverines	1,571

Such figures ought to bring in a large profit to the Hudson's Bay Company, but unfortunately they have not been maintained, and for the last twenty years have been decreasing.

Until 1839 the company was in a flourishing condition. In that year the number of furs exported was 2,350,000, but since then the trade has gradually declined, and this number is now reduced by one-half at least.

The following table, taken from the "Voyages of Capt. Robert Lade," shows on what terms exchanges were formerly made with the Indians. Beaver skins were then the currency employed in buying and selling. The Indians paid

For	Beaver Skins
One gun	10
Half pound powder	1
Four pounds shot	1
One ax	1
Six knives	1
One pound glass beads	1
One laced coat	6
One coat not laced	5
One laced female dress	6
One pound of tobacco	1
One box of powder	1
One comb and one looking glass	2

But a few years ago beaver skins became so scarce that the currency had to be changed. Bison furs have now the medium of trade. When an Indian presents himself at the fort the agents of the company give him as many pieces of wood as he brings skins, and he exchanges these pieces of wood for manufactured articles on the premises, and as the company fixes the prices of the articles it buys and sells it cannot fail to realize large profits.

PURIFICATION OF DYE WATER.

AN experiment has recently been conducted upon a commercial scale and under the most exacting and difficult conditions which promises to deliver the Yorkshire woolen trade from an exceedingly difficult position. A plant was erected, at a cost of not more than $1,946, and it has now been working daily for some time, turning out an effluent which, if not always colorless, is quite clear, entirely free from acid, and altogether innocuous, at a cost for labor and material of less than 1 1/3 cents per thousand gallons treated. The plant is exceedingly simple. It consists of three parts—an elevated tank carried on brick piers, an old 30-foot boiler with the flues removed and the ends made good, set at an angle of about 30 deg., and another old boiler converted into a filter and standing vertically on end, all of which are connected by pipes 4 inches in diameter, having the necessary controlling valves. The plant is designed to deal with an average flow of 30,000 gallons in ten hours, but the flow may on occasion exceed 3,000 gallons in the hour. The elevated tank is simply a wooden reservoir, about 2 feet by 10 feet, to hold about half a day's quantity. Into this tank the crude dye water is pumped, and here it receives an admixture of lime in the proportion of 3 or 4 pounds of dry lime to every thousand gallons of the liquor to be treated.

From the tank the liquor is carried by a pipe to the bottom of the tilted boiler, or, rather, cistern, for it is only as a cistern that it is used. The outlet from the boiler is at the top of the incline, and the liquor flows in at the bottom—therefore against the whole weight of the contents of the cistern. It is by this device of using an inclined cistern from which air is excluded for the purpose of a settling tank that the efficiency of the process consists.

MODE OF ACTION OF THE SCREW PROPELLER.

A SUMMARY OF PROF. FLAMM'S EXPERIMENTS.

At the meeting of the German Shipbuilders' Association in November, 1907, Prof. O. Flamm described the experiments which he has undertaken for the purpose of gaining an insight into the character of the movement caused in water by screw propellers of various forms, acting under diverse conditions. Many vague notions still prevail in regard to these movements, a more accurate knowledge of which will probably furnish the explanation of the action of the screw propeller; and this explanation will possess great practical value, as it will lead to the knowledge of the structural and other conditions of maximum propeller efficiency. This question is of especial interest at the present time, when the introduction of turbine motors has emphasized the need of propellers capable of working efficiently at high velocities of rotation.

Many ingenious mathematical theories of the action of the screw propeller have been elaborated, but none of these theories has stood the test of practice or revealed the secret of the movements of the water. Hence the first object of Prof. Flamm's experiments was to make these movements visible. For this purpose a tank about 30 feet long, 27 inches wide, and 1 inches deep was constructed, the greater part of the sides and bottom being made of glass. A screw propeller 4 inches in diameter was mounted at the end of an arm projecting downward from a light carriage, which runs on rails laid on the sides of the tank and carries an electric motor by which the propeller is operated. The depth to which the propeller is immersed can be varied by raising and lowering the arm. The carriage is driven along the rails by the thrust of the propeller. A cord, which passes over a pulley and carries a weight at its free end, may be attached to either end of the carriage. The weight, being raised by the motion of the carriage, represents in some measure the resistance opposed by the water to the progress of a ship. The motor is so constructed that the speed of the propeller can be gradually increased, up to 4,000 revolutions per minute.

All the measurements are recorded automatically on a revolving drum covered with paper. The time is given by a seconds pendulum, the revolutions of the screw by spark discharges. The speed of the carriage and the energy consumed by the motor are also recorded. As the efficiency of the motor and the resistance to progression (the weight) are known, the energy delivered to the propeller, the work performed by it, and its efficiency can be calculated from the record inscribed on the drum.

The movements of the water are photographed in a series of stereographic kinematograph pictures. The illumination is furnished by two 27,000-candle-power electric projectors. Sixteen pairs of photographs are taken in a second, with an exposure of 1/1,000 second.

The pictures prove that the movements of the water are determined chiefly by the air which is drawn in by the propeller. They show a symmetrical spiral outflow, a tubular void behind the hub of the propeller and a conical depression in the surface of the water over the blades. But even these interesting and instructive stereographs fail to record the fine details of the water currents. To accomplish this result it will be necessary to make the elementary currents visible by suspending fine solid particles in the water and to make 80 exposures per second. Apparatus capable of this speed is being constructed.

Meanwhile Prof. Flamm believes that his preliminary experiments have established the following facts:

1. The rotary velocity of the propeller can be made much greater than the speeds now employed without diminishing the thrust.

2. The depression over the propeller must not be deep enough to reach the blades, as the presence of air greatly diminishes the efficiency.

3. The axial thrust is a maximum when the depression is just perceptible.

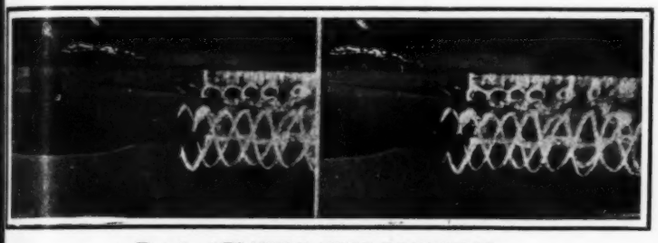


FIG. 1.—ATLANTIC TYPE PROPELLER.

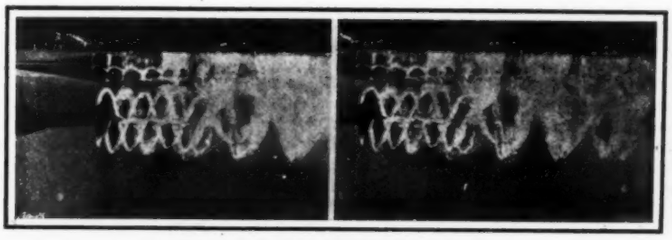


FIG. 2.—TORPEDO BOAT PROPELLER.

FIG. 3.—TORPEDO BOAT PROPELLER—CAVITATION BEGINNING.

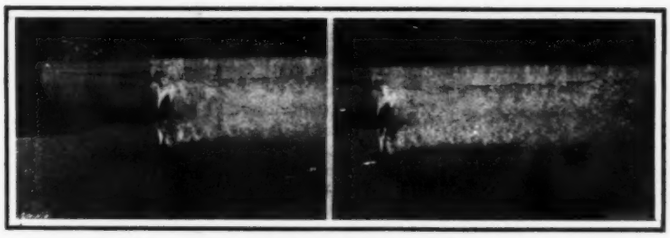


FIG. 4.—LORENZ PROPELLER.

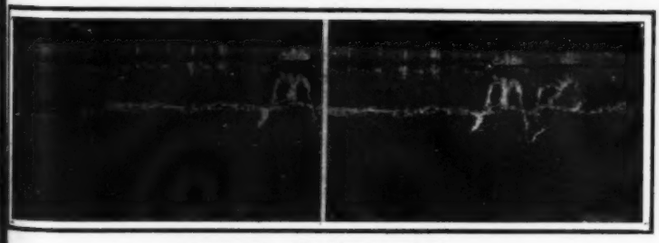


FIG. 5.—ZEISE PROPELLER.

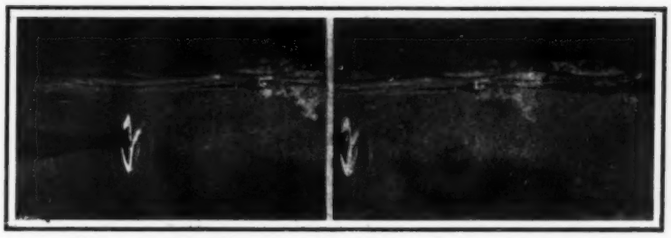


FIG. 6.—ATLANTIC PROPELLER—CAVITATION BEGINNING.

THE PRODUCTION OF ALKALIES AND BLEACHES BY ELECTROLYSIS.

A process for the electrolytic treatment of alkaline chlorides was patented by Watt in 1851, but the first attempt to employ the electrolytic method on a commercial scale was made in 1889, at Griesheim, near Frankfurt, by the German "Elektron" Company. In the following year the establishment was using 900 horse-power and in 1892 its capacity was increased 1,800 horse-power. The same process was afterward employed at Bitterfeld, in Saxony. In 1892 the English Electrochemical Company, using the Richardson and Holland patents, began to operate a large factory at St. Helens, Lancashire. The Castner process, patented in 1892-3, was exploited by another English company in 1895, and in 1899 a third company began operating under the Hargreaves-Bird patents.

In America the electrolytic decomposition of salt was commenced in 1892 by the installation of a plant at Rumford Falls, which used the Le Sueur diaphragm bath and produced three tons of bleaching powder per day. Five or six years later the Matheson factory, using the Castner bath, was started at Niagara Falls with a capacity of 2,000 horse-power, which has been tripled by the present owners, the Castner Electrolytic Company.

The present condition of the electrolytic production of alkalies and bleaches is shown by the following table:

Country.	Active factories.	Total horse-power.
England	2	10,000
France	1	2,000
Switzerland	1	1,000
Germany	7	16,400
Austria-Hungary	3	3,200
Italy	3	6,000
Spain	2	3,700
Belgium	1	1,500
United States	7	9,200

Since 1900 the industry has suffered depression due to the competition of establishments employing the Le Blanc chemical processes.

STUDIES OF BLOOD CORPUSCLES.

It is an observed fact that mammals, contrary to the other animals of the vertebrate order, possess red corpuscles of the blood which do not contain a nucleus. The nature and origin of these special corpuscles has been the object of numerous researches, but up to the present we are not definitely fixed as to the mode of formation of these bodies which do not present the characteristic features of a veritable cell with the cell-plasm and nucleus. After the work of the specialist Hayem, it was considered that the red corpuscles were formed by the growth of small particles without a nucleus, known as hematoblasts, which exist in a free state in the blood and which become charged with hemoglobine. On the other hand it was asserted that the special red corpuscle is not a cell, but a nucleus which is derived either from a conjunctive cell or a white corpuscle or else from a red corpuscle having a nucleus. Others supposed that the special red corpuscles come from other red corpuscles which possess a nucleus, but had lost this latter. However, the processes of such phenomena were a discussed point. It was even said that the nucleus existed in the corpuscle but that it was difficult to observe. M. Jolly, a French scientist and well known from his original work upon the elements of the blood, has recently taken up this question and published an extensive memoir on the subject not long since. He maintains that in the blood of mammiferous embryos in course of development there exist two distinct generations of red corpuscles. The first is the voluminous cell representing the first blood

cells of the embryo, which at a certain period of their evolution undergo an atrophy of the nucleus and cease to further multiply. To this first generation succeeds another which is formed of corpuscles possessing smaller nuclei and these become charged progressively with hemoglobine and are rapidly multiplied. At a certain time the nucleus undergoes different physical and chemical changes and is reduced to a small chromatic globule which is expelled from the cell. The atrophied nuclei which are expelled are found to disappear afterward, being mainly consumed by the other cells. According to this theory the special form of red corpuscle is therefore one of the usual kind which has lost its nucleus, and of which only the shell remains.

THE FAKED AND THE FORGED ANTIQUE.*

THE WILES OF THE FORGER AND THE SNARES OF THE DEALER.

BY TIGHE HOPKINS.

When the active tourist had well begun his active tours in Egypt it was manifest that there would soon be lucre in them for the native. The reason, of course, was that the active tourist wanted to buy things. He must convince the people at home that he had really "been there," had visited bazaars, penetrated into the desert, and made free with the tombs of the Pharaohs. He had heard, or he came to know, that relics were about; and relics therefore were his suit.

Now there were in those days, as there are in these, bits of true Egyptian past to be procured: papyri, scarabs, portraits painted in wax, tools, weapons, coins, ornaments, caskets, vases, statuettes, and the quaintest toys. But there were not, concisely speaking, enough to go round—for the name of the active tourist was legion. What of that? Given the demand, and the measureless credulity of the ordinary tourist, the market was bound to be supplied. The uninstructed tourist was great upon papyri, so a papyrus that was principally guile grew quite naturally into a valuable "line." Rolls of papyri, unfolded and cut into lengths, were rolled again on wooden sticks the ends of which were concealed. Out of a single roll many could be fabricated—and they were all quite good enough to wrap cheese in. By and by came the Röntgen rays, which bring the wooden sticks into view, but the manufacturer does not care twopence for the Röntgen rays. He substitutes a roll of pasteboard, which deceives the rays themselves.

Destiny conducted one happy tourist to a flint hippopotamus of the twelfth dynasty. Who would not possess a flint hippopotamus of the twelfth dynasty? This hippo, tailless and practically legless, the seeming sole survivor of an Ark antecedent to Noah's, multiplied like Israel or the locust.

Mummies have been (and doubtless are) procurable on terms. Cleopatra has not yet, I believe, been on offer; but a Dresden doctor, old enough to have blushed for the subterfuge, did with base contrivance fabricate out of the corpse of a fair young girl the mummy of Queen Nitokris (who was or was not the wife of Nebuchadnezzar), and sold the same for its weight in gold. Plain Antwerp schist was the basis of a Rameses, King of Egypt, manufactured at a cost of eleven hundred francs and disposed of for one hundred thousand. From a king or queen to an idol, a bronze pan, or a coffin head, there is a tariff—and a grand opening for a bargain-chop.

But it should here be strictly stated that, so far as the Egyptian peasantry and Arabs are concerned, much of the industry is of the most straightforward kind. Counterfeit scarabs, images, toys, jewels, and utensils of all sorts can be bought as such, and at very ordinary prices. The illegitimate trade starts mainly when the articles pass to those European dealers whose clients are imperfectly informed upon the arts and industries of ancient Egypt.

Similarly, there are factories in Belgium, Bohemia, and elsewhere which exist solely for the production of "mediæval" and other glassware. Ancient glass is rather easily imitated by various modern processes, and can be turned out to order by the ton. In the factories themselves all this ware is sold cheaply in its factitious character; but let it leave its place of origin and travel into marts remote, and it forthwith assumes a very different quality.

Briefly, the commerce of the fraudulent antique is at present coextensive with the trading world. It is among the few forms of roguery in business that are practically exempt from punishment. Your butcher or baker may not sell you short weight, but the man at the bric-a-brac shop, if to cozening inclined, may falsify his stock and get the better of you in every deal, and seldom does justice reach him. Often, of course, the detection of these forgeries is anything but a simple matter. The trained expert may be deceived as surely as the veriest amateur, and all-round knowledge in the matter of antiques is probably nowhere to be had. You would certainly not find it in any court of law. Again, whereas the housewife whose domestic bills are punctually settled will stand very little nonsense from her tradespeople, the man who buys a flint hippopotamus of the twelfth dynasty, pluming himself on his Pharaonic lore, and subsequently finds that the mild Egyptian has done him in the eye, will be disinclined to boast himself a victim. For a hundred reasons, then, this commerce flourishes almost unharmed.

To the seeker of curios it matters little whether he runs over to Paris for a week, drops down to Rome, or adventures into the heart of Persia: the wicked, in the persons of the sellers of new lamps for old, are ever with him. I have been reading the newest book on Persia, a very entertaining volume by M. Eustache de Lorey and Mr. Douglas Sladen. In the land of the Lion and Sun business is still conducted much in the style revealed to us by the "Arabian Nights." Inspectors, disguised in the hideous sack that the Persian woman wears abroad, go up and down the bazaars; and for the merchant detected in wiles there is immediate woe. The bastinado is the least of it. M. de Lorey, strolling through the bazaar one day, saw a butcher strung up at his own door with hooks through his heels, requiting in this uneasy way an attempted sale of damaged meat. But when the purchaser is a mere infidel from European parts, the eye of Persian justice looks another way. No Cadi orders the bastinado for those dealers in the carpets, arms, coins, and antiques in general that are specially and very astutely prepared for the Feringhee. Persia is perhaps not a whit worse than India. The deeper you dip into the gorgeous East the more extravagantly are you held at fee.

This commerce in the sham antique extends to almost every article that is largely in demand, and to many articles that are not. Build your house beautiful (the style of which will doubtless be inaccurately copied from some other age or country) and fill it with the wonders which you shall fondly think have been gathered from the corners of the earth. Arrange your old masters in your picture gallery; hang up your fine tapestries; lay down your carpets from the East; let your cabinets be rich in gems, cameos, miniatures, and medals, and your portfolios in rare engravings; let your bedroom be not one day more modern than Louis Seize; include among the ornaments of your library a few notable bindings and some half-dozen priceless specimens of illumination; scatter a "Strad" or two in the music-room; and dispose in the halls the arms and weapons of persons who might well have been your ancestors. Amid this embarrassment of treasures there is perhaps not one absolutely honest piece. All, all the objects in the millionaire's collection can be most exquisitely faked. You have really not a notion how many there are of those flint hippopotami of the twelfth dynasty!

Does your fancy rest perchance on old coins and medals? Many learned connoisseurs have abandoned this hobby altogether, the truth being that there is no getting even with the coiner. No one with a large collection of coins knows exactly what he has got. The counterfeiter, wisdom being precious to him, has left off the foolish practice of melting coins in a mold. He strikes them from a die. Also he has learned that in days gone by steel dies did not exist; he now makes his of bronze. It is extremely difficult to be even with him. Some one may remember the instructive affair of the beautiful imitations of the Keutschacher Rubentalern of 1504. True specimens of each of these would fetch from twelve to fifteen hundred florins, but who can any longer tell the real from the Brummagen? A certain man got hold of a Keutschacher Rubentaler, and at once perceived a future for himself. In a well-reputed mint, where his designs were not suspected, he succeeded in getting made for him a useful number of imitations of this interesting thaler. Next he prepared impressions of it in tinfoil, and dispatched them to collectors, asking if they had one to sell at 1100 florins. Now there are perhaps not six genuine coins of this sort in Christendom, and no connoisseur who was written to had a specimen. The man waited a while, and wrote again to the same collectors, saying that he had a Keutschacher Rubentaler to offer for 700 florins. In the hope of making 400 florins profit, most of the collectors leaped at the bait. The forger realized the future he had glimpsed, and you could now obtain a Keutschacher Rubentaler almost anywhere—but had better leave it for somebody else. Here, as will be seen, few of the collectors could resist the chance of a stroke of profit at a brother amateur's expense; but was it not long ago declared that no collector could possibly possess a conscience?

You may have a taste for MSS. You would like to own some splendid example of the period of Charlemagne, which revived the art of staining. How many authentic manuscripts of the eighth, ninth, and tenth centuries are scrupulously preserved in libraries, I know not. The number must be very inconsiderable, but there are artificers who would not for a moment boggle at producing one. Certain documents of the nature of diplomas, written in the Latin tongue, are probably not now forthcoming of a date earlier than the fifth century; but I doubt not that some able craftsman would fake you such a work to perfection. The industrial arts have advanced so wonderfully in our day that manuscripts are copied with a skill which passes comprehension; and not even in the reproduction of the old impression are there any serious difficulties to overcome. The little mistakes of the manipulators of a past generation would nowadays be avoided. The redoubtable literary forger, Wenzel Hanka, who had no thought of lining his pockets, but wished only to endow his country with a nice treasury of old Slav poems, forgot in the ardor of fabrication that Prussian blue, in which color he had drawn some letter purporting to be thirteenth century, was not discovered until the beginning of the eighteenth. Yet more egregious was the blunder of the Greek Simonides. This forger, whose motive was not the patriotic one of Hanka, unaccountably overlooked the fact that most animals have eyes in their heads. Working on a parchment derived from the skin of a head, he mistook the eye-holes for natural defects in the material; and instead of skipping or writing around them, he treated his MS. at this point as though the middles of two words had disappeared. Such solecisms we may hope would not mar the performance of any felonious artist of these days. A good magnifying glass, it may be observed—which should be applied to every word and every letter of every word—will expose any common forgery in MSS.

Furniture, we are all aware, has been most strangely wrought upon. Any new craze in bedsteads, mantels, chairs, settles, chests, coffers, armoires, cribs, clocks, panels, cradles, thrones, or shakedowns is at once responded to. Orders can be punctually filled in—but I will name no names of thoroughfares. Certain things, of course, we may not hope to see. It would be a bold contriver that should seek to impose upon the least sophisticated customer with a Danish whatnot, a Saxon sideboard, or a Norman cabinet tollet stand. "Saxon, and Norman, and Dane" we may be, but our knowledge of the domestic equipment of these progenitors is neither extensive nor peculiar. Come down, however, to any era of which any first-hand scrap of furniture has survived, and somewhere in your walks you will behold the living image of it and will be asked to buy it as original. One would in no wise say that Sheratons have ceased to be procurable, but is not your Sheraton likelier to be merely Sheratonian? Heppelwhite, as limited in design as Sheraton was versatile, would be an easier model for the copyist, but there has never been the same tremendous run upon him. All of them, however, Inigo Jones, Wren, Grinling Gibbons, Chippendale, Manwaring, Ince and Mayhew, the Adams, and the rest, have been incessantly preyed upon—and most of them can be copied to a turn. Wood is susceptible of treatment as ivory is, but it is by no means always necessary to be at the pains of treating it. Old houses are pulled down every day, and every old house is full of the nicest old worm-eaten wood. You want an ancient door with a hinge and a lock to match? Any barn from Kent to Northumberland, has the door you want, and you will not need to hunt for lock or hinge. They can both be made for you at an hour's notice—date and pattern to order—and decently rusted in acid. Chests, cabinets, cupboards—inlaid or as it pleases—are wor

* World's Work, London.

at this day just what the purchaser will pay for them; but he may be assured that he can get the best "antiques" made to his own command infinitely cheaper than he will buy them from any shopman who knows his business. Out of a single piece of attested wood, removed from a chair, a settee, or a sofa, a whole article may be constructed; and a fair half of the "bargains" in furniture are made up in this way. Upholstery is doctored more easily than wood. Is velvet the material? Wash it, do but wash it, and it looks and smells of the Middle Ages.

The theme at once the widest and the tritest in this field of debate is the picture market. If a greater number of persons insist on buying old masters than there are old masters to be bought, what can be done? Ask the dealer! He will provide the answer—and the masters. Astonishing results are achieved in this line. The explanation is the simplest possible. The *chefs d'œuvre* of the past cannot be increased in quantity; there are but so many of them in the world, and the finest are in hands that will never let them go. But year by year new collectors come to the front, new galleries are established; and the reiterated cry is for canvases that are literally not to be acquired. Seemingly, people don't and won't believe this. "Good," says the dealer in effect; "if you will have them you shall"; and he finds you a lovely Correggio, of the most consummate execution.

It is needless to detail the fakements of this industry, if indeed it were possible to detail them in full. They include a good deal of botcher's work and much that is of the highest refinement. At its best, the falsification of pictures is an art almost as elegant as the painter's own. Of the dubious canvases submitted every year to expert criticism, a certain proportion will puzzle the elect. They would puzzle and might confound the masters themselves. On the other hand, it is to be remarked that a little clever jugglery will go a pretty long way. The proper application of licorice juice insures a charming tone, and a judicious mixture of cinders and gum gives a layer of the dirt of centuries. The canvas may be old and brown and genuine, the faded sale mark on the back of it may be incontestable; but over a quite valueless picture a true copy of a valuable one may be painted; signatures can be simulated, and frames are not unadaptable. It wears an ancient and goodly countenance, and is in the main apocryphal. A fictitious picture with a signature is almost universally preferred, they tell us, to a veracious work that carries none; and if this is the case, the dealers are deliberately invited to traffic in forgery.

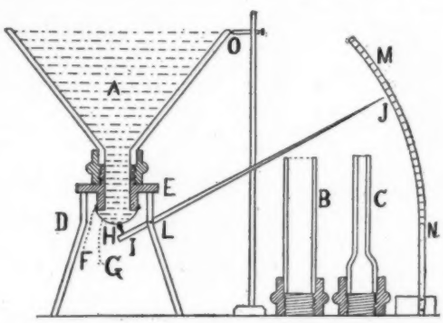
An old friend of mine, himself an artist of distinction, was recently a visitor at a well-known English spa. Calling one afternoon at a picture-dealer's in the town, he there saw, to his no small amusement, a number of works signed "Crome," "Constable," "Stanfield," and so forth. These audacious canvases were on sale at some $200 apiece. One does not forget that when Constable died (in the year of Queen Victoria's accession) his studio was full of unsold pictures; but neither does one forget that Constables are not at this day to be bought at the price of $200. Yet it must be presumed that sundry among the clients of this dealer would consider that here were bargains of the first water.

Then there is what is humorously known as the "portmanteau picture." This confection (so far forth as I understand it) is made up of various portions of works by acknowledged masters—a head from one, a figure from another, a landscape from a third—and Belgium and Holland are said to manufacture it in shiploads for the English and American markets. This is the work of the artist-forger called the "blender," who unites with the "cleaner" or "restorer," the "dirtier," the "sealer," the "genealogist," the "monogrammist," the "face-man," and the "name-changer" to form a curious brotherhood in a trade which, says Mr. M. H. Spielmann, "has its rogues in greater number probably than its honest men."

In what degree, if in any, is the alteration of pictures admissible? It is an awkward question to reply to. In a general way, nevertheless, it may be suggested that there are alterations, repairs, "embellishments" (as the trade affectionately styles them) which are not quite correctly described as falsifications. A connoisseur, for example, who is himself a skilled restorer, buys an undoubted original in a miserable state. Sooner than intrust it to a cleaner in the trade, he will renovate it with his own hand, and by the time he has finished with it the picture has become once more a thing of beauty and its intrinsic value is enhanced. But is it any longer an impeccable work? Its intrinsic value is greater, but has not its historical value diminished? It has been trimmed, glued, patched, and painted over; it is not now to an appreciable extent the creation of the brush that first set it on the canvas. How far is it in its altered state a fraudulent affair? The question could not well arise (or would at least be an indifferent one) while the owner kept his purchase on his own walls. But suppose he were to sell it, or present it to a public gallery? It would then, beyond question, be his duty to show his own part in the renovated work.

An exhaustive catalogue of the things that are faked or counterfeited would run through a page. Jewelry in the precious metals should always be suspected. The gems of this sort very rarely find their way into the open market, and one that does so is usually "a jewel manufactured in pieces, being really a genuine article of very simple workmanship which has been covered with ornamentation and flourishes." Enamels are imitated so inimitably that the imitations will often fetch excellent prices. Engravings forged by chemical methods will stand the closest scrutiny. Artistic bindings are removed from books worth nothing in themselves and fitted to others that are in request. Missing title-pages are concocted as readily as frontispieces. Weapons and armor are fabricated all over Europe. Imitation lace—which is of any kind—may suffer from its mechanical evenness of pattern, but in fineness it will rival the unsophisticated product. The microscope has come unwittingly to the aid of the violin forger; and this, in two or three words, makes a rather interesting story.

No musical instrument has been more extensively falsified than the violin, though at one time it was thought that the masterpieces of Stradivarius, Guarnari, and Amati were charmed against the imitators. What were their secrets? Did the mystery reside in the shape, in some subtlety of varnishing, and had time contributed in any degree to the melodious power of the instruments? "But shape and varnishing can be imitated," says a modern expert, "and as to time, the wood can be dried. For no one nowadays believes that by usage alone the atoms of wood in the instrument are disposed in a new and more favorable manner." The microscope revealed a great part of the



AN EASY METHOD OF ILLUSTRATING THE "HYDROSTATIC PARADOX."

magic. It pointed out that "the violin makers of other days used only to employ wood grown in a certain way, and the rings of which were superimposed in a particular manner." This wood is of a most uncommon kind, but it still grows, and may be found. Hence your "old" violin is another thing that can be made to order.

"Old" bronzes, again, produced by the thousand, are so like the real articles that the very *patina* or incrustation which forms after burial or exposure to weather—once so difficult to counterfeit—is there in the truest color. A veritable world of simulacra.

Glassware has already been referred to. It is much sought after, and not very difficult to counterfeit. Dr. Hans Gross, in an exhaustive chapter on the varieties of cheating and fraud, says that in the old fortress of Rilgersburg there is a window in the dining-hall on which are engraved the words: "Drinking began the 17th of May, 1549, and was kept up until St. Vincent's day, and every day all were drunk." This little window "has already been replaced many times, and for each renewal a collector believes he has the real one."

But it is the guileful potter who finds as excellent an account as any one in the simplicity of buyers pre-ordained for hoaxing. Beyond calculation are the bastard trifles in clay that carry their deceptive qualities over the world. There seems a kind of blarney in pottery; it wins to the purse. The potter, too, has a certain grievous pull over us. He works in the same clay that the ancients used; his baking process seems identical with theirs; chemistry puts him up to every dodge of color; and he has but to step into the nearest museum to procure models in abundance. Mercury, that tutelary deity of rogues, is with him at his wheel. Range upon adjacent shelves ten false and ten unimpeachable Tanagra and Myrrhina figures; it will tax the knowledge of very learned men to distinguish them.

Dr. Gross makes us privy to one of the innumerable tricks in the "antique pottery" trade. "Whoever wishes nowadays to sell a well-imitated article does not expose it in the shop of a merchant, but places it in the ancient garret of some poor widow who swears that it has come down to her from her grandparents, at whose house she played with it, and she finishes by deciding to let it go for an enormous sum. Every day are such stories told, and one can hardly help laughing when one sees the happy owner unfolding a certificate given him by the widow, which certifies that the jug sold to-day (here follows a detailed description of the jug) is a gift made by Count X——— to his nurse, the grandmother of the vendor." Guides and hotel touts are often hired by the dealer to persuade the tourist that they have found some unique treasure in the cottage of a peasant.

French and German museums contain many specimens of the work of that extraordinary forger of pottery, Michael Kauffmann of Rheinzabern. Michael, who was no other than a village master mason, carried his game on for forty years, discrediting "the Roman art trade with his flying tortoises and other attributes of the gods," and inventing inscriptions which the pundits are wrangling over to this day. Michael must have had a heavenly time. He was brought to book at last (and only) by a slip that should have been credited to him for a culminating joke. He fashioned an Emperor Antonius with Hessian boots and a full-bottomed wig.

AN EASY METHOD OF ILLUSTRATING THE "HYDROSTATIC PARADOX."

By CHARLES H. SMITH.

WHILE the method of illustrating this principle of the "Hydrostatic Paradox" here described is not new, it has not received the recognition which it deserves. The accompanying figure makes the method plain.

D is a support for the three vessels, *A*, *B*, *C*. To the lower end of the base *E*, to which the three vessels are successively screwed, is fastened by thread or a metal collar *F*, a piece of not very heavy sheet rubber *G*. Pressing against the middle of this rubber is the knob *H* of the pointer lever *I J*, *L* being its fulcrum. *MN* is a scale to indicate the rise of pointer. Before any liquid is placed in the vessels the pointer is adjusted in a horizontal position. When a liquid is put into the vessels the middle of the sheet rubber is pressed downward and the end *J* of the pointer rises. It will be found that when the liquid level reaches the same height *O*, in each of the three vessels, the pointer will likewise have risen to a corresponding division on the scale.—School Science and Mathematics.

GREAT CITIES OF THE WORLD.

THE population of the great cities of antiquity is not accurately known. Seleucia has been credited with 600,000 inhabitants, Alexandria with 600,000 or 700,000, Rome in the reign of Augustus with 800,000, Carthage with 700,000, but these estimates are little better than guesses.

We are better informed concerning the population, past and present, of modern cities. With the nineteenth century began a new era, in which cities have developed far more rapidly than ever before. In 1801 there were only twenty-two European cities with more than 100,000 inhabitants. These cities were London, Dublin, Paris, Marseilles, Lyons, Amsterdam, Berlin, Hamburg, Vienna, Naples, Rome, Milan, Venice, Palermo, Madrid, Barcelona, Lisbon, St. Petersburg, Moscow, Warsaw, Copenhagen, and Constantinople. Of these cities only two had more than half a million inhabitants, namely, London with 958,600 and Paris with 548,000. Next came Naples with 360,000 and Vienna with 231,000.

At the present day Europe contains 160 cities with more than 100,000 inhabitants, 55 with 250,000, 25 with 500,000, and 7 with one million or more. The population of the 25 largest cities of Europe, according to the latest censuses, is:

London	4,758,000	Naples	585,000
Paris	2,763,000	Amsterdam	564,000
Berlin	2,040,000	Birmingham	553,000
Vienna	2,000,000	Milan	550,000
St. Petersburg	1,429,000	Madrid	540,000
Moscow	1,359,000	Munich	539,000
Constantinople	1,106,000	Barcelona	533,000
Glasgow	848,000	Dresden	517,000
Hamburg	803,000	Marseilles	517,000
Warsaw	756,000	Rome	516,000
Liverpool	746,000	Copenhagen	514,000
Budapest	732,000	Leipzig	504,000
Manchester	643,000		

America has three cities with more than one million inhabitants, namely: New York, 4,113,000; Chicago, 2,049,000; and Philadelphia, 1,442,000. In Asia, also, there are several cities with populations exceeding one million.

Paris, the population of which was estimated at 120,000 in 1220, and 540,000 in 1675 in the reign of Louis XIV, contained 1,053,000 inhabitants in 1851, and 1,794,000 in 1872.

SCIENCE NOTES.

A striking assertion is made in one of the circulars of the United States Forest Service, to the effect that under average forest conditions it requires more than 190 years to grow a 30-foot white-cedar telephone pole. Yet the average life of such a pole, when set in the ground in its natural state, does not exceed 15 years. In other words, in order to meet even the present annual consumption there must be nearly thirteen trees growing in the forest for every 30-foot cedar pole standing to-day. But poles can be made to last twenty or twenty-five years by a simple treatment of their butts with wood preservative. Furthermore, fire-killed or other wood standing in the forests can be treated by preservative to be made durable and useful. Hence, the government considers the subject of wood preservation highly important. Creosote and zinc chloride are used to impregnate the wood. Both are excellent antiseptics. Zinc chloride is the cheaper, but creosote is superior in that it is insoluble in water and will not wash out of the timber.

To how great degree the large variety of proteins of both animal and vegetable tissues have chemical and physiological individuality has long been an unsettled question. There is plenty of physiological evidence that the circulating proteins contained in the blood and lymph of different species of animals are unlike each other in some respects at least. Blood serum from one species introduced into the circulation of another species causes marked disturbance and even a fatal result. Animal proteins are plainly different in some respects from those of vegetable origin, while the latter derived from different sources vary greatly among themselves. We can readily conceive of individual proteins playing quite different parts in the nutrition of man and of animals when taken as food. There may be radical and logical differences in the nutritive value of animal as compared with vegetable proteins, although at present we have no positive proof of such differences. Arguments for or against vegetarianism, which are now based primarily upon questions of sentiment, may in time rest upon a solid foundation of fact. Such observations as have been made bearing upon the constitution of proteins are beginning to have special significance because of the radical differences in chemical make-up shown by the individual proteins studied. Take, for example, phaseolin from the kidney bean. This protein, as shown by both Osborne and Abderhalden, yields about 15 per cent of glutaminic acid, 4 per cent of lysine, 2.5 per cent of proline, 5 per cent of arginine, etc. Excelsin from the Brazil-nut, on the other hand, yields by hydrolysis 16 per cent of arginine, 13 per cent of glutaminic acid, 1.6 per cent of lysine and 3.6 per cent of proline; while the hordein of barley yields no lysine whatever, but furnishes 36 per cent of glutaminic acid and nearly 14 per cent of proline.

In 1873 Clerk Maxwell in laying the foundations of the electromagnetic theory of light, which has been so strikingly confirmed by the researches of Hertz and the application of electromagnetic waves to wireless telegraphy, was led to the conclusion that light exerts pressure upon the objects on which it falls. The observed forms of the tails of comets had already suggested to Kepler the existence of a repulsive force emanating from the sun and caused by the pressure of the sun's rays. So long as the emission theory of light prevailed the idea of pressure exerted by the material corpuscles which luminous bodies were supposed to emit found ready credence. At present, the pressure of radiation is assumed to be due to the energy developed in the direction of propagation by the electromagnetic waves and associated waves of matter. During a long period all attempts to measure this pressure failed, giving very discordant results, some of which are now known to be 100,000 times too large. This was due to the fact that the early experimenters made no attempt to eliminate the radiometric effects caused by the heating of the rarefied gas which filled the vessels in which the registering apparatus was placed. These effects are strikingly shown by the well-known Crookes radiometer, or vacuum mill. Lebedew finally succeeded in obtaining concordant results, according to which the pressure exerted by the rays of the sun is very small, amounting even in the tropics only to ½ kilogramme per square kilometer (less than 3 pounds per square mile). The radiation pressure is almost negligible in comparison with the sun's attraction, which is millions of times greater. But the radiation pressure is proportional to the area exposed to radiation, while the attraction is proportional to the mass of the attracted body. Hence, if the earth were resolved into dust and this dust were spread out in a plane perpendicular to the direction of the solar rays, the radiation pressure might equal or even exceed the attractive force. It is owing to radiation pressure that the fine particles of the nebulous envelope which surrounds the head of a comet are repelled from the sun in streams, which form the comet's tail.

ENGINEERING NOTES.

It appears that the authorities of the German State railways have concluded that incandescent gas lighting is superior to electric light in railway cars. No more cars are equipped with electric light, and the engineers, after long and exhaustive tests, have satisfied themselves of the value of the former system of car lighting, and are now changing over the equipment at the rate of 500 to 600 lights a day.

An interesting railway will be opened in Moscow, Russia, in the near future. The line forms an irregular oval round Moscow at various distances from the city barriers. It intersects all nine of the Moscow railway lines, and will be used for transferring goods from one line to another, thereby saving cartage and also considerably relieving the congested state of the streets of Moscow. It will also tap a whole series of factories which have hitherto been off any line.

Reference is made by the Engineering Record to three oil tanks which have been used since 1900 by a Portland cement manufacturing company to store cylinder, crank case, and block oil, respectively. The three chambers are placed side by side, forming a tank 13 feet 4 inches wide and 16 feet 9 inches long, and approximately 12 feet high. This is sunk in the ground and has a light frame house over it. Each tank holds 2,000 gallons. The concrete was made 1:2:4, using stone crushed to pass through a 1-inch ring. The inside of the tanks was plastered with a rich Portland cement mortar, well troweled in order to give a dense finish. No leakage has ever been detected, although it is often asserted that oil will destroy concrete.

According to a report by Prof. G. Weber in a German contemporary, efficiency tests of a Diesel motor of 200 horse-power, driving a direct-coupled three-phase generator in the power plant of the foundry of the L. von Roll Ironworks at Berne, showed the following results: Fuel used, petroleum residuum; fuel consumption in pounds per kilowatt-hour at switchboard, 0.62 at maximum load, 0.62 at rated load, 0.66 at three-quarter rated load, 0.77 at half rated load, 1.42 at quarter rated load. The generator efficiency varied from 91.5 per cent at full load to 77.5 per cent at quarter load, including friction and ventilation losses at 1 per cent of full load. The thermal efficiency based on effective horse-power was computed at 33.6 per cent for rated load, 32.4 for three-quarter load, 28.7 per cent for half load, and 18.7 per cent for quarter load, while the thermal efficiency based on indicated horse-power was 47.3 to 44.1 per cent, being maximum at half load.

One of the earliest of the old Outram-ways—from which the modern tramways are supposed to have derived their name—has just been closed for traffic, after an honorable career extending over 113 years. This interesting link with the past is the property of the Derby Canal Company, and connects the terminus of their waterway at Little Eaton, about two miles northeast of Derby, with the famous coal pits at Denby, Kilburn, and Marehay. For a good many years the section beyond Mr. Drury-Lowe's pits at Denby has been closed, and latterly the chief patrons of the old line have been the Derby Co-operative Society, who have annually brought some 10,000 tons of coal from Denby for the use of their members at Derby by means of the tramway and the canal. The line, however, is out of repair, and it has been estimated that the Midland Railway Company can perform the service more economically and with less trouble. After more than a century's good work, it is recognized that the "Gangway," as it is locally termed, has outlived its usefulness.

A paper on the prevention of rust was recently read by Mr. Thornton-Murray before the Birmingham University Metallurgical Society. The author first dealt with the theories of rust. It was once considered to be due to chemical action, carbon dioxide and water being necessary for its occurrence, and the compound formed having the formula $2Fe_2O_3.3H_2O$. This supposition has to some extent been modified by an electrolytic theory due to Cushman, who considers that the action is mainly promoted by irregularities in the metallic surface, though the presence of carbon dioxide and water greatly facilitates matters. Turning to the prevention of rust, Mr. Thornton-Murray described the various methods employed for this purpose, including tinning and galvanizing, and showing that, of the different varieties of iron, some resist rusting action to a greater extent than others. In conclusion, he mentioned a method, due to Mr. T. Corlett, of Birmingham, which consists in immersing the article in a hot solution of some phosphate and an iron compound. This covers the metal surface with a mixture of ferrous and ferric phosphates, and presents a pleasing dull black appearance. The process, it is said, makes the iron highly resistant to corrosion, and is adapted for light engineering work, such as cycle frames, gun barrels, stampings, and press work.

TRADE NOTES AND FORMULÆ.

Soluble Cayenne Pepper.—Two parts of Cayenne pepper are digested for two days with 3 parts of alcohol, and then percolated. To the finished tincture, two parts of common salt are added, rubbed down well with it in a mortar, evaporated at moderate heat, and the Cayenne salt obtained passed through a coarse sieve.

To Protect Paint Against Dampness of Cable Walls on the Weather Side.—Take 25 parts of pitch, 15 parts of rosin, 3 parts English red and 6 parts brick dust and boil in a kettle, stirring constantly. Then add ¼ of the volume of oil of turpentine, so that the mass flows on properly and apply it, as thin as possible, with a stiff brush.

Artificial Pumice Stone.—According to a German patented process, dustless, ground pumice sand is mixed into 10 to 15 per cent potash or soda lye, so that to 100 quarts of lye there are about 200 pounds of pumice sand. The whole is boiled in a water or steam bath, stirring in the mean time, until the mixture has become pasty. This stiff mass is then placed in molds and exposed, in a baking oven, to a temperature of 572 deg. F. (300 deg. C.), which is quickly raised to 1,292 deg. F. (700 deg. C.). By this means, an active outpouring of water-vapor is brought about, so that the mixture is reduced to a perfectly pumice-like, porous mass, which is adapted for sharpening purposes.

Washable Printing Ink.—Take 5 parts of acetic acid and dissolve in it 1 part of lunar caustic. This solution is allowed to stand for a day, then add 20 parts of copal varnish, to which a little black has been added. Inasmuch as the brown tone of the caustic, especially when the wash has been exposed to the sun, predominates after repeated washing, it is advisable to give the printing a greenish tone, by wetting it with water, in a few drops of which iodide of potash has been dissolved. This color should be used as fresh as possible, and for this purpose the lunar caustic dissolved in acetic acid and the copal varnish solution should be kept in tightly closed bottles, from which as much as is necessary for the printing may be taken in the desired proportions.

Bronzing Wood.—For this purpose dilute water-glass solution is recommended; with the latter, the wooden object is uniformly coated, bronze powder dusted on from a wide-mouthed bottle, over the opening of which a gauze is bound, and the surplus removed by gentle tapping. The bronze powder remains so firmly attached, that with the aid of an agate tool it can be burnished. This process is recommended, especially for damaged picture frames, for book stampings, etc. For a good gold or bronze ground, the following recipe is recommended: With 1,000 parts of linseed oil, boil 25 parts of impure carbonate of zinc, 100 parts of red lead, 25 parts of litharge and 0.3 part of chloride of mercury, until a drop taken out remains like a pea on a glass surface. Before it is completely cold, the mass is thinned with oil of turpentine to a thick, sirupy consistency.

Blood Fertilizer.—I. The process of manufacture consists in passing high pressure steam through the blood, in order to bring it to boiling and coagulation; hereupon, the coagulated, still hot blood, is transferred, by means of a pump, on to a filter of linen, stretched over a frame and the coagulum, freed from the greater portion of its liquid, is packed in cloths of strong linen folded over one another and placed between the plates of a hydraulic press; the complete drying then follows in a bath having four compartments, into which hot air is conducted. II. A mass produced by a mixture of fresh slaughter-house blood, acid phosphate of potash, carbonate of potash, chili-saltpeter and blood meal (ground dry blood) is thoroughly mixed with mixtures consisting of dextrine and sulphate of potash-magnesia on the one hand and silicate of soda, soluble in cold water, on the other hand, dried and ground.

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